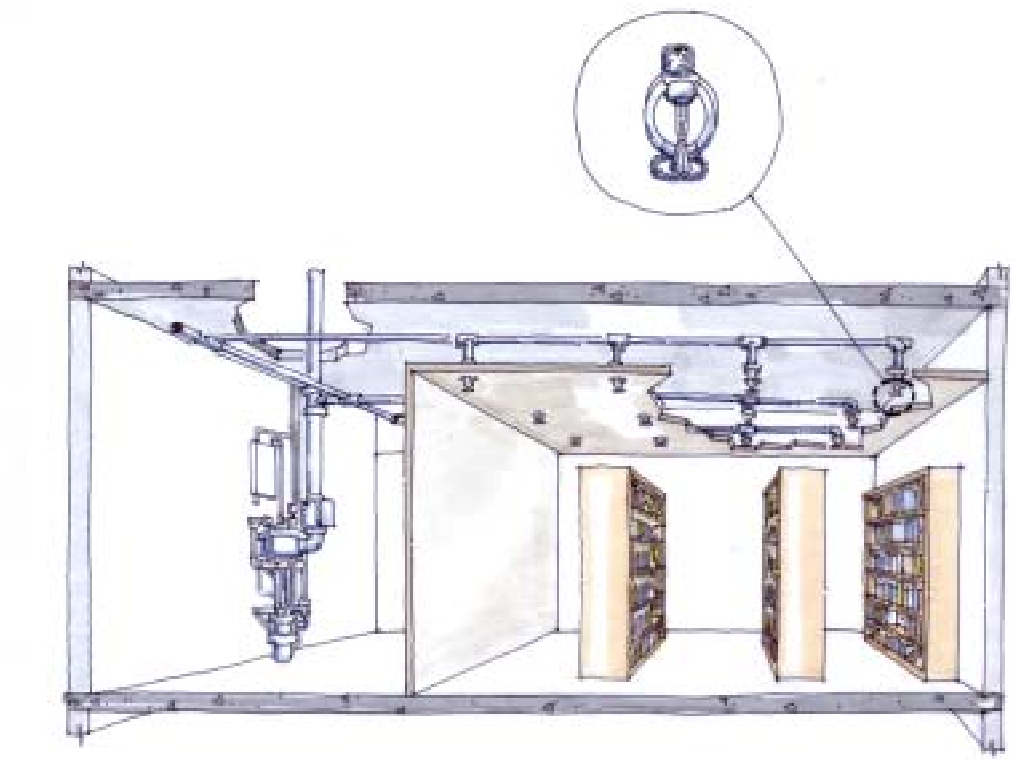
Collection Preservation in Library Building Design



Collection Preservation in Library Building Design. This material was originally created by Barclay Ogden, Library Preservation Department, University of California, Berkeley. Valuable review and contributions were provided by Edward Dean AIA of SMWM Architecture, San Francisco, and Steven Guttmann of Guttmann + Blaevoet Mechanical Engineers, San Francisco. Illustrations were done by Michael Bulander, Architect, Los Angeles. The publication is provided through the Libris Design Project [http://www.librisdesign.org], supported by the U.S. Institute of Museum and Library Services under the provisions of the Library Services and Technology Act, administered in California by the State Librarian. Any use of this material should credit the authors and funding source.

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1. COSTS AND BENEFITS OF COLLECTION PRESERVATION

Addressing collection preservation as part of library building design helps to protect the collection against catastrophic loss and to reduce library expenses by extending the collection's service life. The purpose of collection preservation is to manage risk to an acceptable level, while acknowledging that avoiding risk altogether is impossible.

The collection is the library's single largest asset; designing the building that houses it to maximize protection against major losses including earthquake, fire, water damage, and theft, is responsible management of public resources. Designing an indoor environment (including temperature, humidity, air quality, and light levels) conducive to preservation extends the collection's service life by slowing down its rate of physical deterioration. Books and documents intended to be kept in the collection permanently will not need to be replaced as often, saving the library money.

Preservation costs money to save money; it requires an initial investment in building features and systems to increase protection and reduce deterioration. The library's return on its investment comes as cost avoidance in the years that follow: fewer losses and longer service life. To minimize up front costs, actions to protect the collection and actions to optimize the collection environment should be addressed separately.

All library collections represent a large investment of library funds. Consequently, all library building projects should optimize their design to protect the collections against earthquake, fire, water, and theft. Addressing the preservation needs discussed in the sections below will help minimize the risk of catastrophic loss.

Some collections have to last forever; many libraries have "special" and "local history" collections they want to last centuries, if possible. These collections largely are irreplaceable and therefore need additional features from the building design to maximize their service lives. However, most collection materials in most publicly funded libraries are not added to the collection with the expectation that they will continue to part of the collection indefinitely. These "general" collection materials are expected to be serviceable enough to meet current and anticipated future needs; they will be discarded when they no longer are needed or have been succeeded by more current works.

Opportunities to minimize preservation-related construction and operating costs accrue from distinguishing between the needs of general and special collections. If the two types of collections can be segregated for storage and use, the higher cost solutions needed for special collections can be addressed without incurring the cost of applying the same solutions to the general collections. For example, irreplaceable special collection materials might be stored in a very secure part of the building where there are no emergency exits from the building decreasing the risk of theft, and without water lines or other utilities, decreasing the risk of water damage. Special collection materials could be used in reading areas where sight lines from service desks are unobstructed, providing a sense of vigilance and security for the collection. The relatively challenging environmental conditions needed for storage of special collections might be met more readily and less expensively by locating special collections away from exterior walls and windows where environmental control is more difficult and more costly.

2. COLLECTION PROTECTION

The recommendations for collection protection below apply equally to general and special collections, are the top priority among preservation measures, and should be implemented for all new library construction or major renovations.

2.1 Fire Protection

Library fires are a very common and very serious risk to collections. In the United States alone, an average of 198 library fires has been suffered each year since 1980--one library fire every 1.8 days (*NFPA 909*, p 35).

From the point of view of survival of collections, popular belief for some decades was that more books and documents were lost to malfunctions and unwanted discharge of water-based fire suppression systems than to fire. This led to deployment of non-aqueous systems, aqueous systems based on keeping sprinkler pipes filled with air rather than water until a fire triggered the system to fill with water, and even installation of fire detection systems instead of fire suppression systems.

With modern freeze-drying technology, this perspective has changed; wet materials can be salvaged, but burned materials cannot. Further, National Fire Protection Association (NFPA) fire tests have discounted the mistaken notion that library materials don’t burn readily; studies have proven that library materials constitute a high concentration of combustible material that makes library stack fires, once underway, very difficult to extinguish (*NFPA 909*, p. 90).

Best Practices

Current best practices are to 1) minimize exposure to arson (accountable for nearly a third of all library fires); 2) use compartmentation to limit the spread of fire; and 3) employ fire detection AND water-based fire suppression systems for collection protection.

1) Minimize exposure to arson. Exterior doors in library buildings (public, staff, and emergency egress doors) need to be well attended and controlled, and they usually are. Windows, however, too often are left unattended during library open hours, and left unlocked or open when the library is closed, providing an arsonist with an opportunity to start a fire by tossing into the building burning rags, wadded up paper, or even (on record) Molotov cocktails. Windows that do not open eliminate this risk, or the risk can be reduced by the use of screening to cover windows that can be opened.

A second major exposure to arson comes from book returns that penetrate the exterior wall into library space. A book return built into the wall of a library gives an arsonist easy access to the interior, and often is provided with a convenient fuel source in the form of other books that previously have been deposited in the book return. Much damage has been done by book return fires, including damage from smoke that spreads throughout the building. Best practice is to use stand alone book return bins located outside and away from the perimeter of the building.

2) Use compartmentation to limit the spread of fire. In any book stack, the risk of major damage to or loss of the entire collection is reduced by introducing “compartmentation,” i.e., subdividing the bookstack by constructing fire-resistant walls, ceilings, and floors to limit the spread of fire, smoke, and to some extent, water.

Compartmentation is a highly successful method of reducing risk if barriers are designed and installed properly. Fire ratings must be appropriate for book stacks, and there can be no breaks or interruptions to the barriers. Points often overlooked in the use of compartmentation are continuation of the walls above drop ceilings to the floor above, installation of automatic dampers in air handling systems, sealing of gaps around utility tunnels, and use of automatic fire doors; all are measures designed to help isolate compartments from one another to prevent the spread of fire, smoke, and water. Vertical openings between floors for services, stairwells, and elevators need to be sealed if each floor is to become a separate compartment and barrier to the spread of fire.

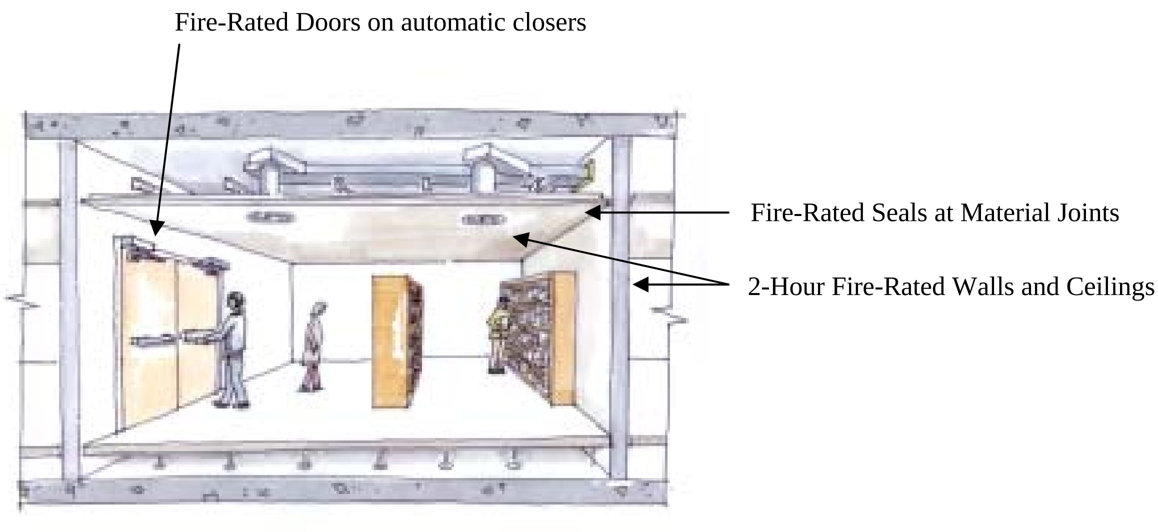

Figure 1. Special Collection Area separated through Compartmentation.

Special collection storage areas often are especially suitable for compartmentation; the collection usually is housed in closed stacks (not accessible directly by library patrons) and often has additional security and environmental requirements that dovetail well with the use of compartmentation for fire protection.

3) Employ fire detection AND water-based fire suppression systems. Fire detection systems include those based on heat sensors, smoke sensors, and products of combustion sensors. Fire detection systems can detect fires prior to triggering the suppression system and, consequently, can buy an extremely valuable few minutes for fire department response. Among fire detection equipment options, products of combustion sensors can detect fires sooner than heat or smoke detectors, so have been recommended when water-damage from the suppression system is to be avoided if at all possible.

Fire Suppression Systems

Most fire suppression systems in libraries are water-based sprinkler systems, but non-aqueous gas, expansion foam, and chemical powder suppression systems also are available. Non-aqueous fire suppression systems based on the use of carbon dioxide are not used in libraries because people can be suffocated by the system when it discharges. Non-aqueous systems based on use of fluorocarbons have been outlawed due to the damage the fluorocarbon discharge can do to the environment. Other non-aqueous suppression gasses are available; see the Halon Alternatives Research Corporation website for alternatives (http://www.harc.org/harcnews.html).

Water-based fire suppression systems utilize a range of delivery technologies from “wet pipe” to “dry pipe” to high pressure “water mist” systems. Wet pipe systems keep the sprinkler pipes filled with water at all times and use temperature-triggered sprinkler heads that open the sprinkler valves at a predetermined temperature (140-155°F). The wet pipe system has proven to be very reliable in many library installations for three reasons: it works when needed, it is unlikely to discharge when not needed (short of someone accidentally breaking off a sprinkler head), and it requires the least maintenance of all types of fire suppression systems. Part of the success of the wet pipe system is due to its simple technology and relatively low maintenance requirements; staff knowledge of suppression systems often is limited, and maintenance schedules are notorious for being deferred to higher priority needs.

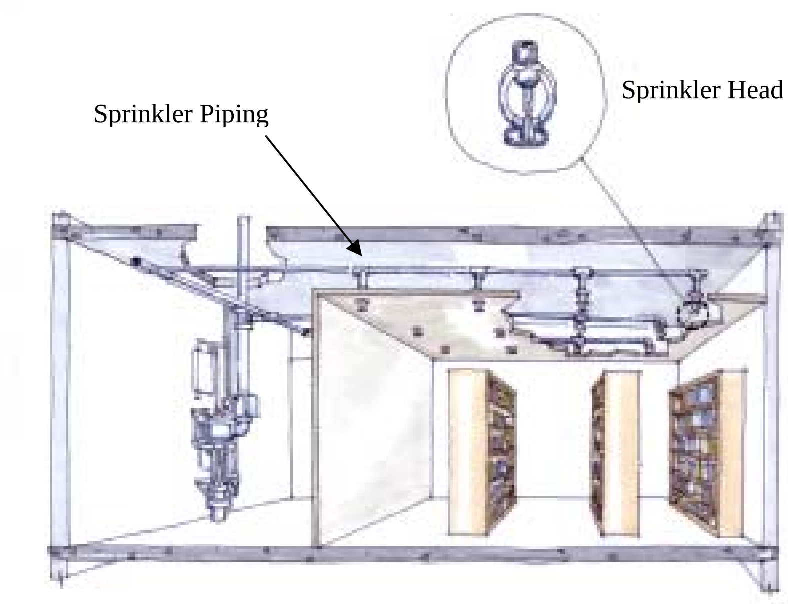

Figure 2. Typical Water Fire Protection System

"On/off" sprinkler heads, once a popular technology designed to limit the amount of water discharged by automatically turning on and off the flow of water, no longer are available from domestic manufacturers following failures and recalls of some designs in the late 1990s.

“Water mist” systems are similar to wet pipe systems in design except that they deliver water under high pressure to specially designed nozzles, creating a fog of fine water droplets that quickly lowers the temperature below that needed to support combustion. The water mist system is designed to use the least water and cause the least water damage, but has not yet been widely deployed for the protection of library collections, so little is known about its long-term performance. However, the monetary and historical value of some special collections may justify investigation of the latest developments in this fire suppression technology.

“Dry pipe” systems are filled with air rather than water until the fire detection system senses a fire, at which point the pipes fill with water. Alternately, a sprinkler head is tripped and opened, which releases the air from the pipes. The pipes fill with water, and water is discharged from the sprinkler head(s) that opened. Dry pipe systems suffer some disadvantages from the preservation perspective: they are slower to respond to a need for suppression than wet pipe systems, and they require more attention to maintenance. In the absence of the required maintenance, they are more likely to fail.

Fire Protection and Cellulose Nitrate Film

Cellulose nitrate film decomposes over time, becoming less stable and more combustible, a process exacerbated by elevated temperatures and storage in concentration. Early motion picture films were made of cellulose nitrate and most commonly have been stored in rolls in film cans. Over time, these films have become a sufficient fire hazard such that the National Fire Protection Association produced *NFPA 40, Standard for the Storage and handling of Cellulose Nitrate Motion Picture Film*, to address their special needs.

Many special collections have significant holdings of early cellulose nitrate sheet film (as distinct from motion picture film), much of it in protective paper sleeves or interfiled with related paper documents and in quite serviceable condition. The most recent edition of *NFPA 40: Standard for the Storage and Handling of Cellulose Nitrate Film, 2001 Edition,* was renamed and extended to the storage of cellulose nitrate still or sheet film, calling for segregation of cellulose nitrate still film from the rest of the collection with storage practices to match those for motion picture film.

The inclusion of sheet film in *NFPA 40* without recognition of its apparently greater stability than motion picture film has led to controversy within the photographic conservation field. As of this writing (2003), the necessity for segregation of cellulose nitrate *sheet* film (as distinct from cellulose nitrate motion picture film) from the rest of the collection for increased fire safety is very unclear, while the costs of constructing separate storage facilities without justification discourage implementation of this NFPA Standard.

2.2 Water Protection

With the exception of the use of water to extinguish fire, water damage to collections is a consequence of a failure of a building system to work as intended. The roof, the windows, the plumbing, the heating, ventilating, and air conditioning (HVAC) system, and rarely, the fire sprinkler system, cause water damage because they have failed. In addition to using well designed and constructed systems, there are two building -related approaches to optimize water protection for the collections: system avoidance and vigilance.

System Avoidance

System avoidance entails eliminating any systems from collection storage areas unneeded to meet the operational requirements for collection storage. While the primary concern usually is water damage, systems that could create a fire also should be reviewed for elimination. Unnecessary windows, bathrooms, utility sinks and other utility plumbing, and roof drains that pass through the building should be eliminated from areas designed to primarily to store collections. If areas are multi-use, including collection storage, compromises will need to be made to accommodate the multiple functions, but at increased risk to the collections.

Vigilance

Vigilance in the form of routine inspection and maintenance is an effective form of water protection. Routine inspection of gutters for clogging leaves, roofs for cracks, the support structure below for tell-tale water stains, joints on plumbing for evidence of corrosion and slow leaks, and interior drains for sluggish performance are among the often deferred facility services. An alternative solution to some routine inspection is installation of automatic monitoring systems that detect water; equipment is available to monitor for roof leaks, water buildup on floors, and wet walls, with options for either local alarms or automated notification to 24/7 monitoring services. A search on the World Wide Web for "water detection" will yield a range of equipment designed for this purpose.

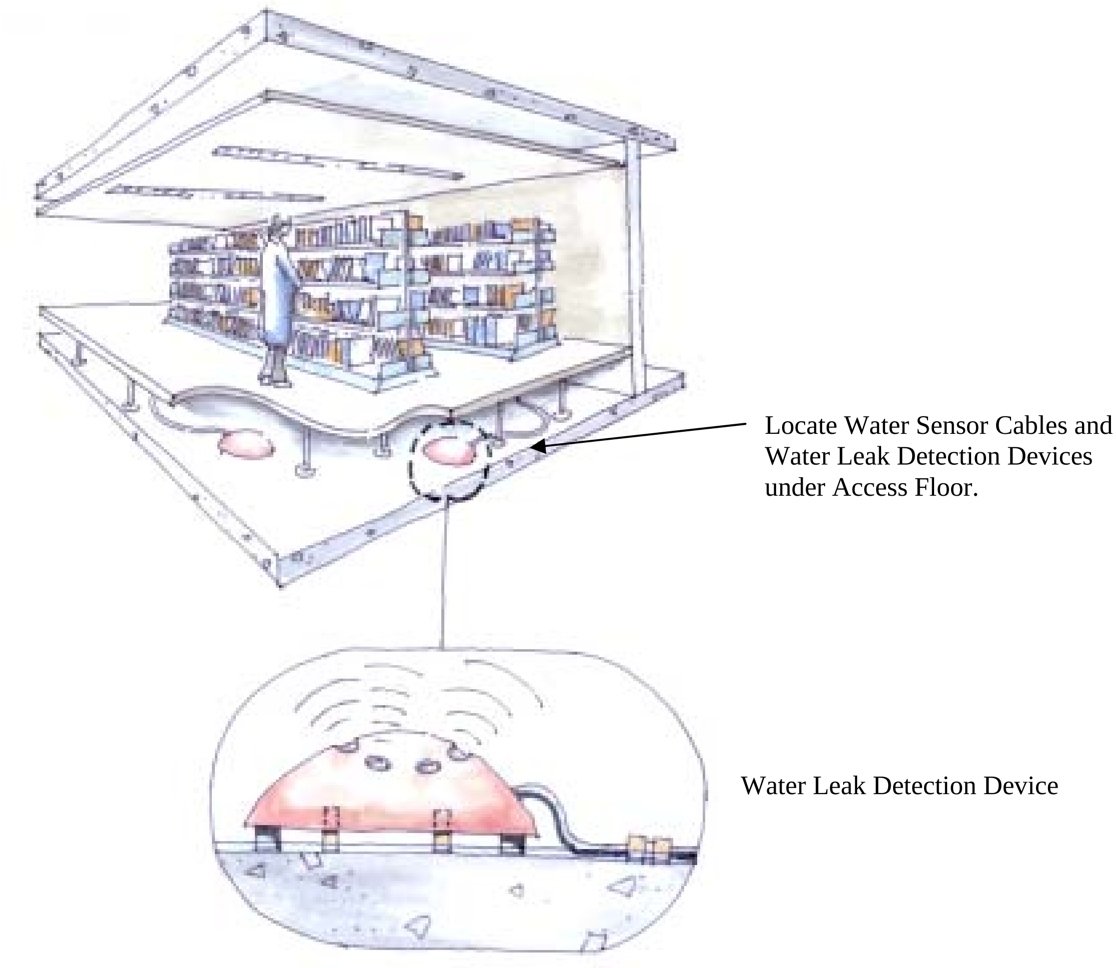

Figure 3. Water Leak Detection under Access Floors

Siting HVAC Equipment

Placing the HVAC equipment on the roof over the collection area is undesirable for two reasons. Vibration from the equipment can cause fractures to the roof's surface, leading to leakage, and the equipment itself can provide water an entry point through the roof to the interior below. Further, the discharge of water from the system has been known to back up until it overflowed into the building. For both reasons, siting the HVAC equipment alongside the building is better than any roof location, and failing that option for aesthetic or space reasons, siting it away from collection areas is recommended.

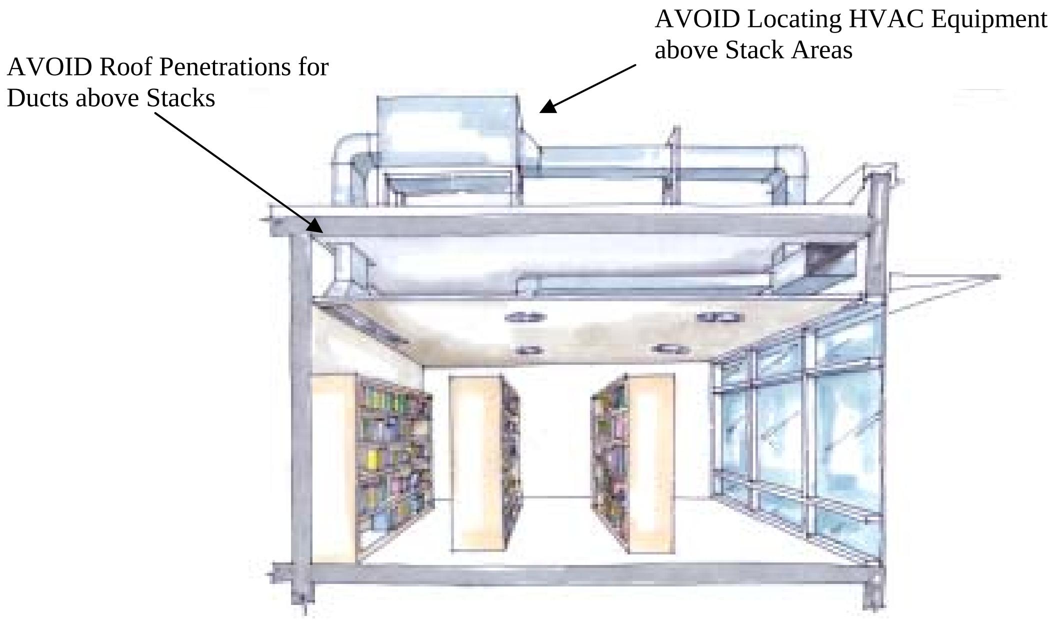

Figure 4. Illustration of Poor HVAC Equipment Siting.

2.3 Theft/Vandalism Protection

Managing access to and egress from the storage and reading areas is essential for provision of good service and protection of collections. Unobstructed sight lines for staff observation of user behavior are a good deterrent to theft and vandalism, as well as beneficial for staff and patron safety. The design and layout of service desks needs to consider points of entry and exit from the library. Key or card access to special collections areas needs to be different from that to the general collections areas to ensure that only authorized staff have access to the facilities and collections.

2.4 Disaster response and collection salvage

Good building design and good preparedness practices reduce, but do not eliminate, risk of disaster. When disaster strikes, the collection is best served by effective and efficient emergency response and salvage. A written disaster response and collection salvage plan, a trained staff collection salvage team, a cache of salvage supplies, and a list of priorities for collection salvage are essential elements of collection protection.

There are several reasons for maintaining a written plan rather than relying on a general shared agreement and understanding:

- to ensure that staff responsible for action have all the necessary information;
- to ensure that all response and salvage staff are using the same information;
- to help staff think clearly and work systematically in high stress emergency situations; and
- to better inform staff whose responsibilities are peripheral to the main emergency response and collection salvage effort.

A generic (fill-in-the-blanks) plan for disaster response and collection salvage is located at the California Preservation Clearinghouse (cpc.stanford.edu), along with a wealth of information on disaster preparedness activities, resources for supplies and technical help, and "table top" exercises to test out the viability of an institutional disaster response and collection salvage plan in response to a particular disaster scenario.

Every disaster response and collection salvage plan needs to include several major components:

- emergency notification procedures (e.g., fire department, police, facilities management, library administration, library supervisors of affected staff)
- outline of the collection salvage operation, including authority and responsibility for the several roles;
- step-by-step procedures for identifying and packing wet materials;
- list and location of onsite salvage supplies, and resources for additional supplies;
- list of priorities for salvage in the event that time and staffing are too limited to salvage everything before parts of the collection become unsalvageable;
- floor plans of the collection storage areas with the location of high priority materials for salvage marked on the plan.

The staff collection salvage team and a cache of salvage supplies are keys to quick action following a health and safety approval to re-enter earthquake-, fire-, or water-damaged buildings. Time is limited for water-damaged materials; as few as 36-48 hours may elapse before irreparable damage (especially from growth of mold)

Figure 5. Sample Salvage Floor Plan Showing Areas of Highest Priority.

begins. The success rate for collection salvage can be very high when salvage actions are taken quickly; recovery rates of 95+% are possible when the library is prepared. At the other extreme, libraries without disaster response and collection salvage plans have been known to suffer near total losses of water-damaged collections.

A secure space should be dedicated to storage of emergency supplies: mops, pails, wet vacuums, folded cartons and freezer paper (for salvaging wet books), plastic tarps, and paper toweling. The space should be located near an exit, if possible, to reduce the risk that impassable areas within a damaged building block access to the supplies.

Equipping the library with a written disaster response and collection salvage plan demonstrates the library's commitment to responsible management and protection of institutional assets, and reduces the risk of accusations of administrative negligence. Engaging a representative of the library's insurance carrier in the preparation of the disaster response and salvage plan can lower premiums for collection insurance coverage. Further, reviewing insurance coverage with the insurance carrier *before* a disaster enables staff to know what steps can be taken immediately in response to the disaster without jeopardizing coverage.

3. ENVIRONMENTAL CONTROL

After collection protection, environmental control is the most cost/effective investment in building design to extend the service life of the collection. The benefits of extended service life and reduced collection maintenance costs, in addition to considerations of human comfort, often can justify environmental control throughout the library. However, if the project budget can support only part of the library to be environmentally controlled, the benefits to irreplaceable collections argue for controlling their environment above other collections in the library.

Special and local history collections are California's documentary heritage. More than a financial investment and asset of the community, these collections often contain the only known copies of old local newspapers, books of local authors, publications about the area, and photos of the town and landscape as it was. Additionally, some local history rooms serve as archives with collections of unpublished papers and scrapbooks of members of the community. These materials often are unique, almost always are irreplaceable, and need to last forever or as close to that as possible.

Categorizing collection materials by environmental needs enables HVAC systems to be designed to achieve preservation goals, energy conservation goals, and to minimize HVAC system construction costs. General collections can be sub-divided usefully into "current collections" and "permanent collections" for HVAC design planning. If a library's general collection consists mostly of current materials, then the cost of achieving appropriate environmental conditions is less than for general collections that consist largely of materials of permanent value.

Current collections are housed in combined stack and user areas, consist predominantly of high use circulating materials, and have a service life limited more by wear from use, and obsolescence from more current editions, than by chemically caused deterioration. Environmental requirements for these materials are minimal: control relative humidity to avoid desiccation from too dry air (which makes bookbindings more subject to cracking and magnetic media subject to static electricity), avoid mold growth from too damp air, and set the temperature to meet human comfort needs consistent with energy conservation goals.

Permanent collections usually are housed in combined stack and user areas, often have low use relative to "current" collections, but have continuing value even as they age. Protecting the investment the library has made in these materials can be enhanced by creating environmental conditions that extend the service life of the collection. In addition to avoiding desiccation and mold growth, the service life of the permanent collection can be extended by reducing temperature to the lowest level of comfort able to be tolerated by users and staff, and by stabilizing relative humidity to help maintain the physical condition of the collection.

Special ("local history") collections usually are housed in stacks separated from users for security, thus providing an opportunity to create desirable environments for each. For these largely irreplaceable materials, preservation goals include both protection of investment and taking all prudent steps to ensure the materials' survival for future generations of library users. Desirable environmental conditions include setting the temperature as low as possible to minimize temperature-induced deterioration and controlling relative humidity to avoid collection damage. The minimum set point for temperature is determined by the limit of the HVAC equipment to achieve the desired relative humidity, and by the difference between the stack conditions and reading room conditions: too great a difference could lead to condensation of moisture on cold materials when they are transferred from the stack to the reading room. See below for further comments on temperature and relative humidity.

Collection category	Temp.,°F (incl. fluctuation)	RH, % (incl. fluctuation)
Current	User comfort	35-65
Permanent	68-72	35-45
Special	60-65	35-45

3.1 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 the casual observer to see, 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, creating tensions between layers that split them apart. Practical consequences of not stabilizing relative humidity are a shorter collection service life and more costly collection maintenance.

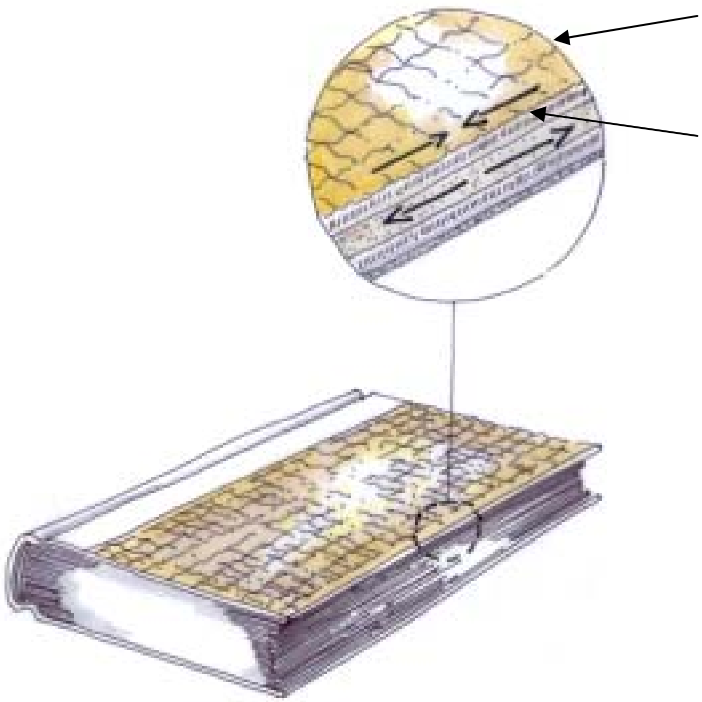

Figure 6. Different Rates of Expansion between Adhered Materials Produce Damage when Exposed to Moisture.

At one extreme, materials that are too dry (less than 30% RH) desiccate and become brittle; at the other, materials that are too damp (greater than 70% RH) encourage mold growth; consequently 35-65% is recommended as the maximum acceptable range for any library collection. However, to minimize damage from expanding and shrinking layers, library materials need to be kept as close as possible to constant relative humidity. For collections of mixed media, a design specification of 40% RH and a maximum of 5% fluctuation (i.e., 35-45% including fluctuation) around the clock [*2003 ASHRAE*, p. 21.8, Table 4 and Michalski, p. 4, Table 4] is an acceptable compromise among different ideal conditions for different media. This specification applies to both permanent and special mixed media collections, in storage areas and in reading environments, where maximizing collection service life is a major goal.

3.2 Temperature Specifications

Heat degrades all organic materials, including paper, photographic film and prints, and analog and digital media. More heat speeds up the chemical reactions responsible for degradation of materials, shortening their service lives. So colder is better, down to reasonable tolerance limits for staff and students who need to work in the stacks. For permanent collections, where bookstacks and people spaces often are combined, the low end of the human comfort zone (68-72°F, including fluctuation) is recommended as the range.

Special and local history collections should be separated from staff work and reading areas, enabling the temperature in the collection storage area to be reduced to as close to 60ºF as possible to maximize the service life of the collections. A range of 60-65°F (including fluctuation) is recommended for closed stacks for three reasons: a) most HVAC systems use "chiller" technology because it is relatively easy to service, but cannot maintain 40% RH at temperatures much below 65ºF; b) moisture condensation on the surface of books is avoided when they are removed from the colder storage area to the warmer reading environment; and c) 60ºF appears to approach the limit of staff tolerance of differences in temperature between the bookstack and reading room work environments.

3.3 Stabilizing Relative Humidity and Temperature

For library collections, stabilizing relative humidity arguably is more important than stabilizing temperature for two reasons:

1) Changes in relative humidity can cause mechanical damage from materials' internal pressures to shrink and expand; they literally tear themselves apart.

2) 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 stabilizing the system at the design temperature with the expectation that a stable relative humidity will follow. This system design works 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 air can hold at a given temperature. As the temperature goes up, the amount of moisture the air can hold rises with it; as the temperature goes down, the amount of moisture the air can hold is reduced. Consequently, in a closed environment with a given amount of moisture in the air (a bookstack, for example), if the temperature goes up, the relative humidity goes down because the capacity of the air to hold moisture has increased. Conversely, if the temperature in the bookstack goes down, the relative humidity rises.

The relationship between temperature and relative humidity can be exploited to the benefit of the collection 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, limiting the amount of expansion or shrinkage of materials, and thereby avoiding collection damage and extending service life.

(Warning: the relationship between temperature and relative humidity cannot be exploited effectively by raising the temperature of the building's HVAC system to "dry out" the collection following a water disaster, e.g., a sprinkler discharge or major roof leaks, because there is a great excess of water in the wet collection, furnishings, and carpets. Raising the temperature only releases yet 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.)

3.4 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 to make recommendations other than to generalize that fewer gaseous pollutants are desirable because they are known to be absorbed by collection materials, and then to combine with moisture to form acidic compounds known to attack paper and film-based library materials. (Some research on damage to museum and library materials from gaseous pollutants is documented in the *2003 ASHRAE Applications Handbook*.) One sensible precaution, however, is to locate fresh air intakes to the HVAC system well away from loading docks or other areas where exhausts of vehicles and other petroleum-powered equipment can introduce unwanted pollutants.

Particulate filtration can be recommended because it provides tangible and visible benefits in reduced soiling of collections as well as reduced maintenance costs for building interiors, furniture, and equipment. Most damaging among particulates is soot, which is a product of combustion of organic compounds and very small in size, less than a micron in diameter. Unlike dust, it is not easily removed from collection materials by vacuuming, making efforts to prevent its entry into the collection environment doubly advantageous. Filtration systems that can remove better than 50% of particulates 0.5 microns and larger, are recommended by Lull, p 7. Further, the *2003 ASHRAE Applications Handbook* warns that high-voltage electrostatic filters may not be acceptable because they generate ozone, which is known to chemically break down paper.

3.5 Light Specifications

Light degrades paper, bookbinding materials, and other library media, reducing their service lives. Ultraviolet (UV), infrared, and visible light all cause degradation of outer surfaces, so each source of light damage needs to be addressed and controlled. Damage is directly proportional to exposure (i.e., intensity x time); more exposure results in more damage. To the extent possible, people should be located in areas with natural light, and library materials in areas with artificial light, in order to better control collection exposure.

Visible light levels recommended for preservation storage and display usually are much below the 30-60 footcandles recommended for task lighting for reading, and

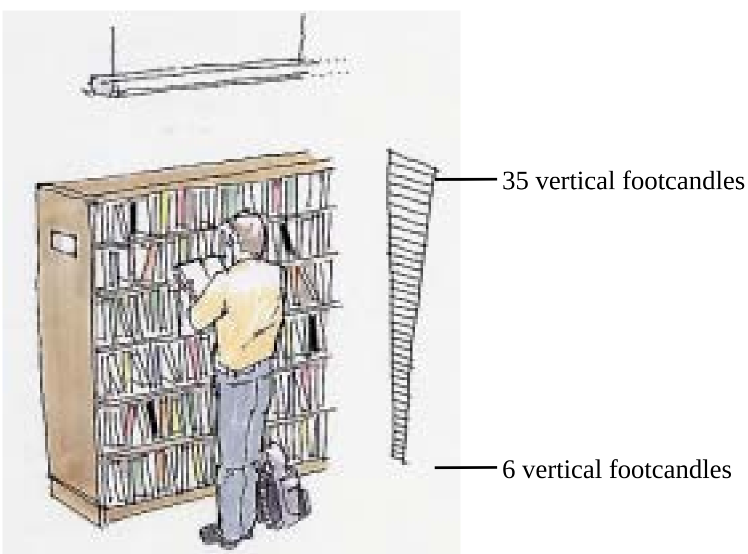

Figure 7. Ideal Vertical Footcandle Distribution at Bookstacks (from Dean).

natural lighting usually greatly exceeds light levels recommended for task lighting. Since less light is better, light levels for the stacks should be set to the minimum acceptable to enable book titles and call numbers to be read. See "Lighting for Libraries" at the Libris Design website (www.librisdesign.org/docs/lighting1.html) for stack lighting specifications: 6 footcandles minimum (farthest from source) and 35 footcandles maximum (closest to source); lighting types and configurations that can reduce the maximum light levels will pay off in reduced deterioration.

Natural and fluorescent light contain ultraviolet (UV) rays, which are damaging to library materials. General collections in areas with natural light should have ranges of shelving set perpendicular to and away from windows whenever possible to avoid direct sun light on spines of books. Special collections storage areas should have no natural lighting; artificial lighting should be equipped with staff-operated local switches so lights can be employed as needed rather than left on continuously or for extended periods when not needed for staff work.

Fluorescent lighting should be equipped with UV shields to eliminate much of the UV. Windows can be tinted with a UV filtering layer, or retrofitted with UV filters. Both actions will substantially reduce expenses for rebinding and repair of otherwise exposed collection materials. Limiting the intensity of UV as a portion of total light exposure to a maximum of 75 microwatts/lumen is recommended (Thomson, p. 21).

Infrared radiation damage is most noticeable when light sources are close enough to collection materials to heat them, causing local damage. This situation can be witnessed in older over-crowded stacks with collection materials stored high on the shelves near incandescent stack lighting. A more common situation in modern libraries occurs in display areas that use hot, high intensity lighting. The lighting can heat up objects even at a distance from them; when lighting is mounted in cases, it raises the temperature of the case environment.

Most collection materials receive more exposure to light when on display than at any other time during their service lives. Display lighting that is left on during all open hours (if not around the clock) cumulates very high levels of exposure and light damage. In an effort to limit damage, visible light levels most often recommended for display of paper-based materials are 5-15 footcandles, a level often lower than surrounding ambient lighting, and often too low to attract visitors to the exhibit. Unless exhibits can be housed in a separate space with low levels of ambient lighting, an alternative strategy is to raise exhibit lighting at least to ambient lighting levels, make sure the lights are turned off when not needed, and to limit the length of time materials are allowed to remain on display.

3.6 Monitoring the Storage Environment.

The storage environment may need to be monitored independently from managing the HVAC system for technical and administrative reasons. The technical reason is the system may be relying on sensors built into the supply or return air ducts, which are not monitoring the conditions in which the collection lives some feet away from the air ducts. The collection can absorb and release moisture to the surrounding air to achieve a relative humidity equilibrium, leaving supply air ducts reporting to the monitors only what the system delivered, not the conditions in which the collection lives. Sensors in return air ducts will measure only the condition of the returned air, which also could differ markedly from the conditions in the stack.

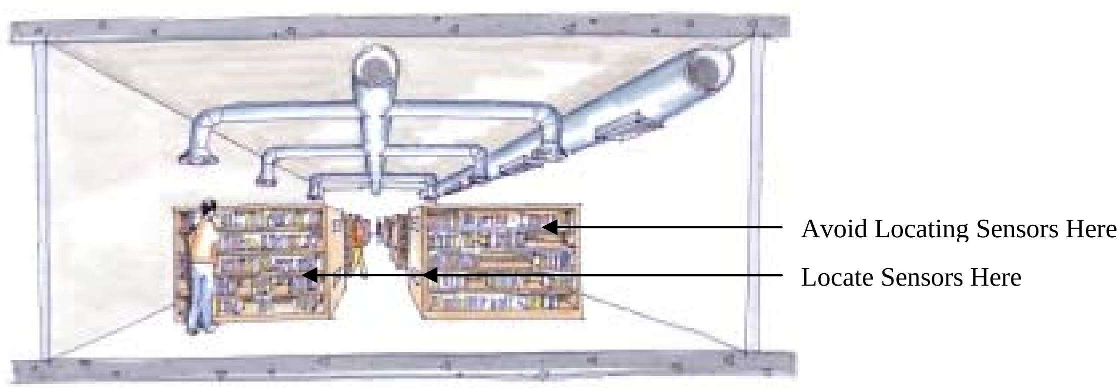

Figure 8. Place System Sensors away from Air Supply Outlets.

System thermostats and humidistats should be located in collection spaces away from air ducts when possible. Even when system sensors are well placed to monitor conditions, independent sensors need to be placed in several locations among the items in the collection and away from all air ducts to aid discovery of microclimates, that is, locales within the stack where conditions differ from the typical conditions in the stack as a whole, and to double-check the accuracy of the system sensors, which can malfunction.

The administrative reason for independently monitoring the environment is that building maintenance engineers often are invested in the performance of the system, not in maximizing the service life of the collection. When there is a potential conflict of interest between system performance and collection preservation, the stack conditions need to be monitored by staff independent from staff assigned to manage the HVAC system.

In new buildings, temperature and relative humidity need to be monitored on a continual basis for the first year of operation of the HVAC system because conditions can fluctuate during the 24-hour day and from season to season in response to changes in climate. Two types of equipment capture and record multiple readings over time, and both are self-contained so they can be placed where needed in the collection storage area: recording hygrothermographs that are constantly reading and recording temperature and relative humidity to a chart, and electronic devices (generically referred to as "dataloggers") that periodically (from seconds to hours) measure the conditions and store the data to electronic memory. Visible and ultraviolet light measurement usually can be spot checked with a meter to determine if corrective action is necessary; unlike temperature and relative humidity, continuous measurement usually is not required because conditions don't change unless the lighting equipment is changed.

Equipment for monitoring environmental conditions is widely available. Equipment for monitoring the performance of an HVAC system can be purchased for a few hundred to a few thousand dollars, depending upon the features of the equipment, a very modest price relative to the cost of the HVAC system, not to mention the value of the collection. Light meters for visible light are available for a few hundred dollars, but UV monitors are less widely produced and cost more. Lists of suppliers with web addresses can be found at the following websites:
http://www.nedcc.org/plam3/tleaf22.htm
http://www.solinet.net/emplibfile/envirsuppl.pdf

4. STACK SHELVING

4.1 Shelving design.

From the perspectives of utility and protection, dry process ("powder coat") finish, steel shelving is the best choice to avoid possible damage to the collection materials from direct contact with the finish. Care should be taken that the shelving system design does not have shelf or brace fasteners that protrude into shelf space with the possibility of causing damage to volumes. Wooden book cases are less functional, i.e., wood has problems with acidity, outgassing chemicals that deteriorate paper, surface finishes that stick to collection materials, and too little resistance to insect infestation. However, aesthetic considerations may lead to their use in public or “donor” areas. One compromise is to use metal shelving with decorative wooden end panels.

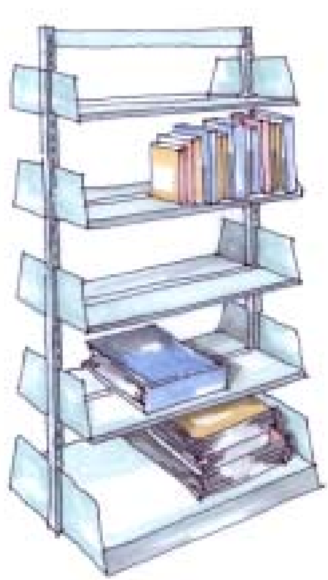

Figure 9. “Shelving Through” Oversize Materials.

Shelves should be deep enough to fully support the bottom edges of books. Oversized materials should have deeper shelves; some shelving designs permit "shelving through" in order to take advantage of shelves on either side of the section. The height of stack ranges and width of aisles need to take into account the challenge of retrieving materials from the high shelves. If a shelf height requires a stool or ladder, aisles must be wide enough to accommodate the ladder and a space to place materials being transported to and from the shelves.

Bottom shelves should be positioned well above the floor to minimize dirt buildup and book damage from booktrucks bumping into the shelving. The shelving system should have an easily removable base cover so the area under the bottom shelves of the range can be dried easily if it gets wet.

4.2 Bookends

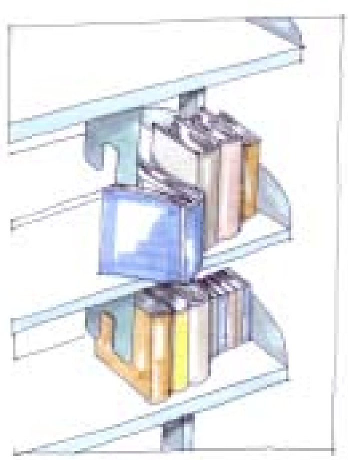

Figure 10. Avoid narrow end profiles for book supports.

The surface of book supports in contact with the books should be solid to avoid imprinting the book covers with the outline of the supports, and should have a wide end profile to avoid books being “knifed” over the supports and damaging the text leaves. Wire book ends that clip to the shelves overhead are a classic example of a book support system that leads to damage to the collection.

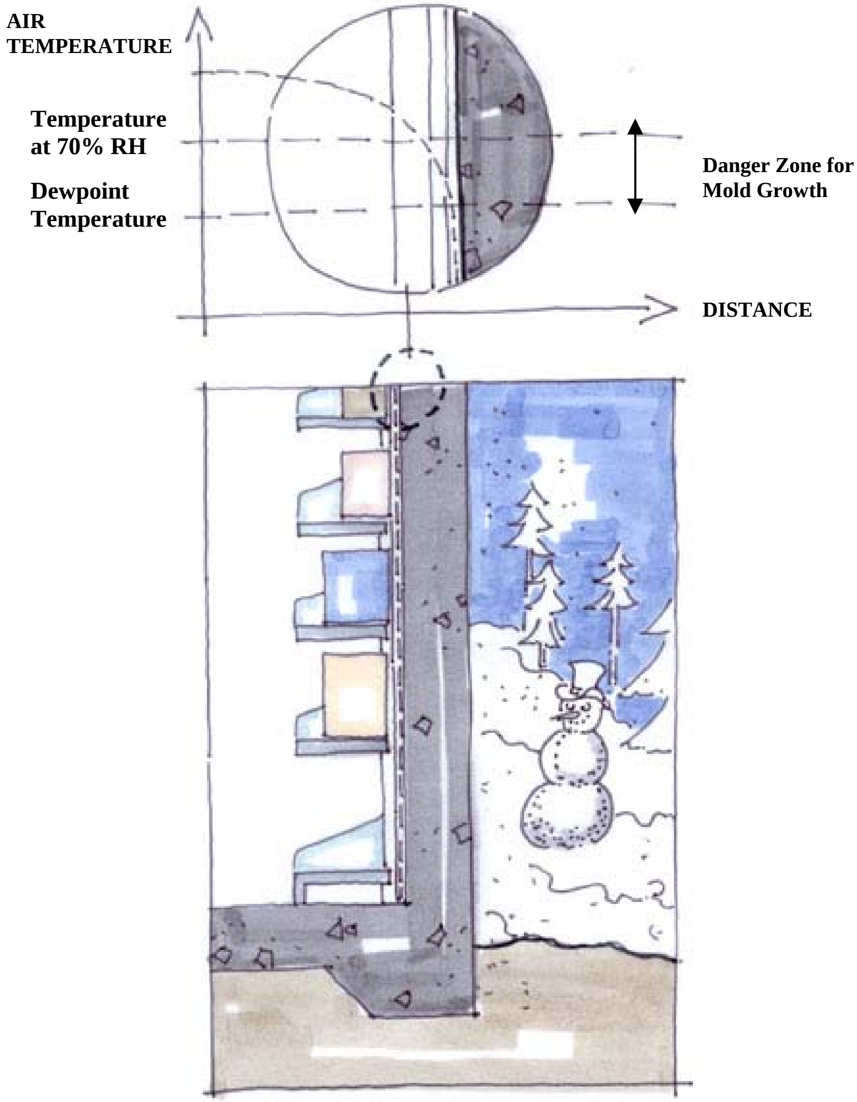

Figure 11. Microclimate of High Relative Humidity Against Exterior Walls

4.3 Exterior Walls and Placement of Shelving

Stack ranges should not be placed flat against exterior walls. Differences in the interior and exterior environmental conditions can result in exterior walls that are warmer or cooler than the interior. High humidity thin layer microclimates can develop against the interior side of exterior walls, leading to mold growth, a problem most likely to occur on "weather walls," that is, the wall facing the direction from which storms predominantly come.

4.4 Stack Carpeting

Salvage of collections and facilities is greatly facilitated by eliminating wall-to-wall carpeting from stack areas wherever possible. Carpeting traps water, making it difficult to dry out the stacks after a water discharge. Further, carpeting that runs under the shelving units provides a breeding environment for rodents and insects.

5. COMMON PRESERVATION CHALLENGES IN LIBRARY BUILDING PROJECTS

5.1 Aesthetics Trump Preservation

Architects often are tasked with creating aesthetically pleasing and functional spaces, leading to potential conflicts between the requirements for each goal. A successful solution for both goals is to separate spaces for collection storage and spaces for reader and staff use. Short of complete separation, a workable compromise is to house the general collection in spaces designed to please readers and staff, and to house special and local history collections in a separate space designed to promote collection preservation.

5.2 Preservation Priorities Get Scrambled

Too often the budget proves not to be adequate to support the ideal building program; compromises need to be made, including compromises to preservation goals for the collection. Setting priorities among preservation goals is a solution; a good rule of thumb is to prioritize collection protection actions above environmental control actions. Within environmental control, favor a separate controlled environment for special and local history collections above environmental control for all collections. When funds are not sufficient to meet all environmental control goals even for special and local history collections, favor meeting relative humidity and temperature goals at the expense of first gaseous, and second particulate, filtration.

5.3 Preservation Costs Energy

Library buildings are designed to save collections. Minimizing energy use is an important, but subordinate, priority to maximizing the service life of permanent and special collections. Consequently, continual advocacy for preservation is needed during the building program process, and continuing vigilance is necessary during the design process to ensure that the design specifications for the HVAC system are responsive to collection preservation needs. Further, after the building is operational, building engineers too often seek short-term savings at long-term collection expense by turning off the HVAC system nights and weekends; every effort needs to be made to keep the HVAC system running continually to realize savings in collection maintenance by meeting preservation needs.

5.4 Some HVAC Engineers Don't Understand Collection Needs

An important difference between HVAC system designs for libraries and for other buildings is the major emphasis on creating and maintaining an environment appropriate for maximizing the service life of the collection. If the engineering team does not understand or appreciate this special need, engineers will argue for changing the design specification based on their experience working with standards and specifications for office, commercial, and residential buildings. Work with the architect to select an engineering firm with experience in HVAC design for stringent environmental control applications and, if possible, interest in care of cultural property.

5.5 High-Tech Systems Are Too Smart for Their Own Good

When systems (e.g., fire protection, air conditioning) fail due to lack of required maintenance, the problem often is in part too little staffing and in part lack of adequate skills among onsite maintenance staff. A highly sophisticated system that requires special training and unusually attentive operating engineers is a system likely to fail in many library building maintenance situations. The realities of limitations of library building maintenance staff need to be included with other fundamental criteria in the design and operation of all building systems.

5.6 Disasters Happen during Construction

The potential for damage from fire and water is significant during any project that involves a major renovation or addition to an existing library building. Workmen whose primary focus is on completing construction as quickly as possible emphasize convenience to themselves rather than minimizing risks to the collection. A staff member should be assigned responsibility for daily inspection of the work site during and following the close of each work day. *NFPA 909: Code for the Protection of Cultural Resources, 2001 Edition*, devotes a chapter to precautions to take during alterations and renovation (*NFPA 909*, pp. 14-17) that can serve as a guide for inspection of practices at the work site.

5.7 Buildings Below the Water Table Get Wet

Buildings designed with underground levels below the water table need special attention to drainage in addition to sealing exterior walls. Relying on sealing the walls alone is very risky because ground shifts, subsequent construction work, and deterioration over time lead to breaks in the water seal and to major problems with water leaking into the building. Special measures can be taken to provide exterior drainage and/or secondary barriers within buildings to compensate for inevitable problems with water when buildings are below the water table.

5.8 Collections Are Moved before the Building Is Ready

Pressure to take occupancy of a new building before it is ready (often due to unforeseen delays or time overruns in construction) is not uncommon. There are significant risks to the collection when this happens: new construction materials and interior finishes still can be outgassing air pollutants, and remaining construction work continues around and over the collection, risking damage to the materials already on the shelves. Find opportunities to rearrange schedules of events to delay moving the collection to the end of the schedule in order to reduce risk of damage.

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