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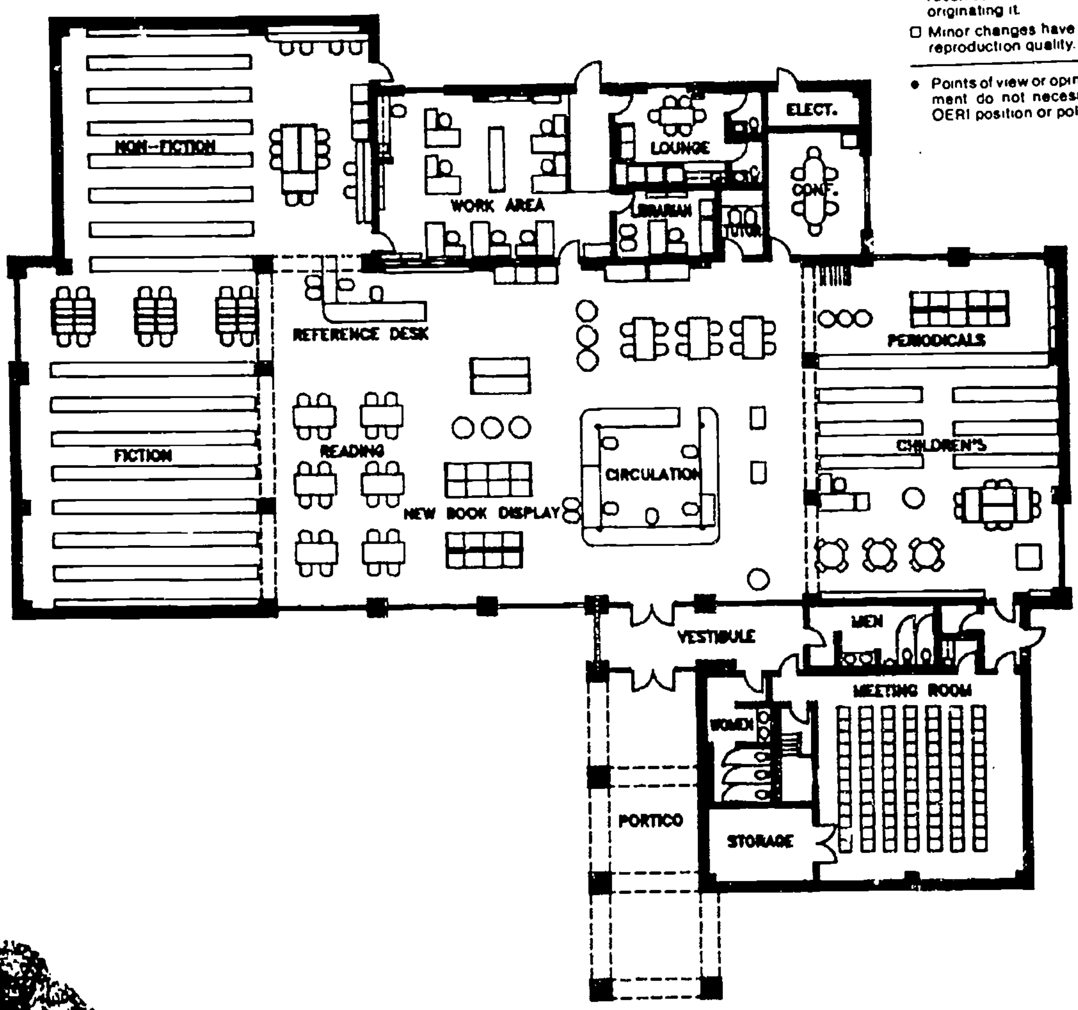
ABSTRACT

To help libraries and other holdings institutions better incorporate preservation concerns in construction, renovation, and routine maintenance, various techniques are presented that allow preservation concerns to be integrated. The following topics are considered: (1) site selection; (2) design of the building envelope; (3) the library interior; (4) floor coverings; (5) roofing materials; (6) electric and plumbing features; (7) lighting; (8) environmental controls; (9) integration of fire protection and security concerns; (10) pest control; (11) use of book returns; and (12) landscaping. Cost concerns are discussed, explaining various cost analyses, the relationship between preservation and maintenance, and why preservation costs provide long-term benefits. Designing for preservation, while likely to increase the short-term capital costs of a new library building, will provide significant cost returns in longer collection life and reduce long-term maintenance and replacement costs associated with the library itself. Various phases of architectural design and construction, and their relationship to preservation concerns, are briefly outlined to help avoid common pitfalls in working with architects, engineers, and contractors. Eight figures and two tables illustrate the discussion. A list of 37 resources for preservation is included; and four appendixes provide specific details about lighting and pesticide use, and a checklist of preservation concerns. (Contains 70 references.) (Author/SLD)

Preservation Concerns in Construction and Remodeling of Libraries: Planning for Preservation



SOUTH CAROLINA STATE LIBRARY

PRESERVATION CONCERNS IN CONSTRUCTION AND REMODELING OF LIBRARIES: PLANNING FOR PRESERVATION

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ABSTRACT

This study will help libraries and other similar holding institutions better incorporate preservation concerns in such building activities as new construction, renovations, and routine maintenance.

Intended for the non-specialist (in either preservation or the building trades) the text provides a variety of techniques which allow preservation concerns to be integrated into such topics as site selection, the design of the building envelope, the library interior, floor coverings, selection of roofing materials, electric and plumbing features, lighting, appropriate environmental controls, integration of fire protection and security concerns, pest control, use of book returns, and landscaping.

A section discusses cost considerations, explaining various cost analyses, the relationship between preservation and maintenance, and why preservation costs provide long-term benefits.

In a time of shrinking budgets, preservation is a strong ally of libraries. Designing for preservation, while likely increasing the short-term capital costs of a new library building, will provide significant cost returns in longer collection life, extending the life of both circulating and special collections -- ensuring the availability of these materials for patron use. In addition, incorporation of preservation criteria are also likely to reduce many of the long-term maintenance and replacement costs associated with the library structure itself.

The various phases of architectural design and construction, as well as their relationship to preservation concerns, are briefly outlined to help librarians avoid many common pitfalls in working with architects, engineers, and contractors.

Finally, this study incorporates essential reference materials, sources for additional programming information, and a list of essential preservation considerations in the building process.

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Many individuals have provided information, offered support, and given encouragement. All of the staff of SOLINET, but especially Ms. Lisa Fox, have provided invaluable assistance. Ms. Julie Arnott, of SOLINET, shared information and materials from the June 1992 ALA/ALCTS seminar, "Library Buildings and Preservation: Design and Planning Considerations." Mr. Harlan Greene, now Director of the North Carolina Preservation Consortium, has often provided assistance and a clear head. Finally, Ms. Sharon Bennett, of The Charleston Museum, has kindly shared information and resources on many occasions.

I also want to thank those who have taken the time and energy to read and comment on this study. Ms. Debi Hacker, Conservation Administrator at Chicora Foundation has reviewed the text, offering additional suggestions and helping to edit the final product.

Mr. Steve Goggans, AIA, of Steven Goggans and Associates, Inc., Pawleys Island, South Carolina, kindly agreed to review this document from the perspective of an architect and has offered a variety of very useful comments and suggestions. Mr. David A. Lyon, IV, Director of the York County Library, Rock Hill, South Carolina, reviewed this publication, providing a very valuable public library perspective. This was supplemented by Mr. John Townsend, Division of Library Development at the New York State Library. Ms. Karen Motylewski, Director of Field Service at the Northeast Document Conservation Center in Andover, Massachusetts, also reviewed the text, offering useful suggestions. The section on The Building Envelope and Heating, Ventilation and Air Conditioning was reviewed for technical details by Mr. Larry Michel, P.E., Charleston Engineering, Charleston, South Carolina. I appreciate all of the time and energy of the various reviewers. Their comments, almost without exception, have been incorporated into the final text, vastly improving its quality and effectiveness.

Naturally, I assume full responsibility for any errors, omissions, or misinterpretations which may have crept into the text. I welcome comments and suggestions from those eventually using this document for inclusion in a revised version.

EXECUTIVE SUMMARY

The library building is the first line of preservation, protecting the collections from temperature, humidity, light, storms, water, fire, pests, and a wide range of abuse. It is therefore essential that librarians understand how to incorporate preservation issues into the library building program.

Too often preservation is seen as the domain of the academic or research library, with little relevance to public libraries. Faced with budget and staff cuts, proactive preservation, such as incorporating preservation features into building designs and plans, can help public libraries meet today's fiscal challanges

The goals of this publication include:

- promoting preservation concerns,
- demonstrating that preservation can be cost-effective,
- helping architects and designers better understand the preservation needs of libraries, and
- developing model preservation guides for use in building plans throughout the Southeast.

To accomplish these goals this report incorporates simple, non-technical advice designed for those with little or no preservation or construction trade experience with more detailed explanations that will acquaint architects and design teams with major preservation concerns.

While this study will help institutions make sound preservation choices, it is not designed to offer "cookbook" solutions. Many preservation questions have more than one solution, and the library should obtain the advice of professional architects, engineers, and preservation consultants. This text is intended to serve as a primer, not a final source.

This publication contains major sections on:

- selecting the library site and incorporating risk assessments in the building plans,
- designing a building envelope that will help rather than hinder preservation,
- determining how the library interior will affect preservation,
- selecting floor coverings for preservation,
- specifying a roof that will protect library collections from damage,
- integrating electrical and plumbing concerns in the building plan,
- designing light with preservation in mind,
- establishing preservation design features for HVAC (heating, ventilation, and air conditioning) systems,
- developing fire protection designs,
- building to exclude common pest problems,

- selecting appropriate security for library collections, and

- generating landscape plans that foster preservation goals.

Since preservation is often viewed only as a cost, a separate section outlines how preservation incorporated in the building plan can help reduce maintenance and other long-term costs. Libraries are warned that frequently short-term cost-savings will result in long-term obligations of staff, maintenance, and preservation time. Libraries should strive to reject the "more-for-less" mentality that has driven the construction market for the last several decades and instead invest in sound construction. By specifying materials that require low to minimal maintenance libraries are often likely to improve collection preservation while reducing overall costs.

Another section helps librarians better understand the various planning, design, and construction stages. Preservation begins with the building plan or program and depends on the thoughtful input of the entire library staff. It discusses how consultants, including architectural design teams, can be selected. The design process is traced through the stages of schematic design, design development, construction documentation, and bidding or negotiation phase, with an emphasis on incorporating preservation concerns into each.

The construction process is briefly discussed, with common preservation pitfalls highlighted. The importance of carefully evaluating the library's preservation environment is explained. The techniques, such as the stable performance test period, punch list, commissioning, independent testing and balancing, that the library can use to ensure a preservation environment are also discussed.

Since this study has been kept simple for those seeking quick explanations of major preservation and technical issues, only the most essential footnotes are included in the text. References are found in a concluding section, along with resources where librarians can obtain additional information and assistance. In order to make the text even more useful, especially to those seeking a quick answer or explanation, an index of major topics, themes, issues, and products is included.

Finally, Appendix IV provides a list of major preservation issues. This serves as a handy "check-list" of essential considerations, useful to both librarian and architect.

INTRODUCTION

Goal and Audience of this Publication

The goal of this publication is simple -- it is intended to help librarians, library planners, and architects design and build libraries with preservation in mind. It is intended to be used by public libraries of different sizes. Even academic or research institutions, small historical societies, archives, and local museums may find the advice and preservation goals beneficial. Ultimately this publication is directed at librarians, specifically those who have little or no background in either preservation or the construction trades.

This booklet was at least partially inspired by Will Manley's March 1989 article in the *Wilson Library Bulletin* in which he bemoaned the absence of clear advice on such topics as air-conditioning that works and roofs that don't leak. This publication intends to put simple, straight-forward construction and preservation advice in the hands of those who need it most -- public librarians.

Why Preserve?

While preservation concerns are frequently addressed by academic and research libraries, few public libraries whole heartedly embrace the concept. There are likely a number of reasons for this reluctance, ranging from a lack of preservation awareness to a lack of funding.

Public librarians often have difficulty seeing how the goals of preservation and the goals of a public lending institution can be simultaneously met, especially with small staffs. They even question why a public lending institution should be concerned with long-term preservation. Public libraries tend to have smaller collections of primarily newer materials than academic or research institutions. Frequently these materials are duplicated by other libraries across the United States, giving the impression that the collections are more expendable. These public libraries frequently believe that preservation problems can be handled by larger acquisition budgets and more aggressive weeding of damaged or deteriorated collections.

The tight fiscal constraints that state, county, and local authorities operate under today suggest that public libraries can no longer count on large acquisition budgets. Combined with reduced budgets, aggressive weeding of collections will mean a reduction in offerings to the public.

One study conducted at the public library in Wellesley, Massachusetts[1], documents the crisis in preservation. The library serves a community of 27,000 residents and holds approximately 225,000 volumes. The study found that nearly half of the books (46%) were highly acidic, with an additional 22% being moderately acidic. Figure 1, adapted from the Wellesley study, illustrates the types of damage found by collection. It was found that $400,000, representing a third of the total annual budget for all library services, was needed to put the collection in merely good condition. This figure represents just maintenance costs. The article, correctly, cautions that libraries with older buildings and other problems would face even higher costs.

As budgets are strained there will be obvious consequences for books and other collections. Libraries today are finding their budgets are being cut. Preservation can help

[1] Reynolds, Ann L., Nancy Schrock, and Joanna Walsh, "Preservation: The Public Library Response," *Library Journal* (February 15, 1989):128-132.

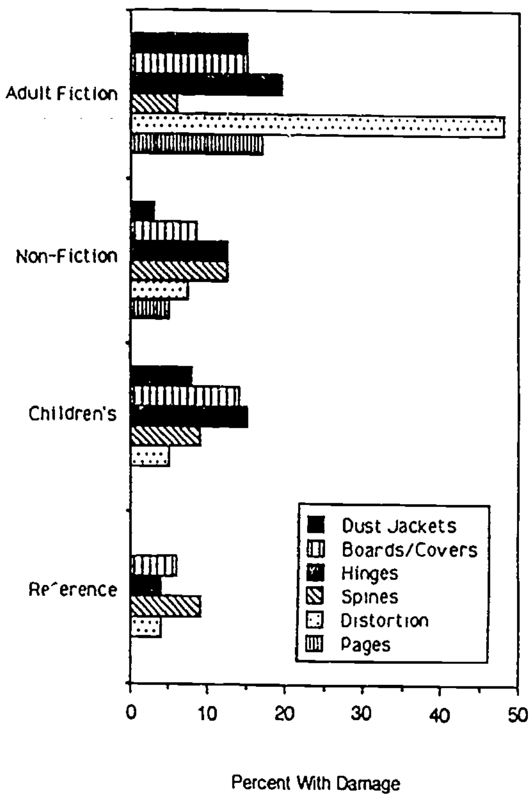

Figure 1. Damage in Wellesley collections.

books last longer and serve more patrons. Preservation can also minimize the threat posed by natural and man-made disasters to the collection.

Sometimes preservationists, in their zeal, have presented the ideal of preservation, while allowing little latitude in approaches or specifications. One example might be the irrational dedication to the 72° F ± 2° temperature and 50% RH ± 3% relative humidity requirements for a preservation environment. Such inflexible approaches have probably alienated many librarians, while little effort was paid to justifying the associated costs.

This publication takes a different approach. An attempt has been made to present the ideal of preservation, and to justify or explain that ideal. Recognizing that many libraries cannot obtain that ideal, alternative approaches are presented which allow a range of preservation options to be explored. In particular, it allows libraries to examine the costs of various options with their architects and designers, selecting those that can be integrated within the existing budget.

It also goes one step further. Planning for preservation at the building level also addresses concerns over limited staffing and funding. This publication encourages what might be called "environmental preservation," or proactive preservation, rather than more time (and cost) intensive reactive preservation. Many of the routine decisions in the design of a library will have preservation ramifications. This study explores these issues, helping librarians more clearly understand how preservation can be integrated into the library with little or no additional cost. For example, many pest control problems could be eliminated or minimized if pest control concerns were integrated into the building design.

Good preservation can provide unexpected, but pleasant, benefits. Attention to light levels, location of windows, and adequate ultraviolet light filtration can keep expensive furnishings, like carpet and upholstered furniture, from fading and wearing out so quickly. Concern with fire and security issues may reduce the cost of insurance. Insisting on sound building practices will help avoid early obsolescence and building failure.

Most recommendations offered here have small initial costs, but will provide major preservation benefits and often major reductions in maintenance costs.

Many public libraries operate under the constant review and oversight of elected county councils. When approaching new building construction or remodeling, the frequent goal (discussed in a later chapter) is to get more, for less. This results in pressure being placed on the library director to cut corners -- and issues relating, either directly or indirectly, to preservation are often the first target. Ultimately those with the purse strings must be convinced that some aspects of library construction simply can't be cut or low-bid.

One technique to help in this process is to bring the county maintenance staff, county engineer, or others concerned with the long-term operation of the new library into the planning early. While county councils may be inclined to ignore library directors, they tend to be less willing to ignore their directors of maintenance or engineers. Often these individuals can emphasize the increased costs of cleaning skylights, or replacing faded furniture and carpet. They can be valuable allies in the fight for a sound, preservation oriented structure.

Anothertechnique, discussedelsewhere in this publication, is to have the architect working for, and with, the library, not the county council or governing body. A knowledgeable architect who understands the importance of preservation issues can help explain why the building should be designed with preservation in mind.

Finally, keep it simple when discussing preservation issues with the governing body, but be sure you understand the issues. For example, some county councils, because of one or two bad experiences with inadequately designed and poorly installed "flat" roofs are opposed to that design. But a properly designed "flat" roof actually has a 1 to 3% slope -- and this should be explained to the governing body (this is also where the cooperation of your architect will help).

Organization and How to Integrate Preservation

The following 13 chapters include a variety of areas where preservation can be incorporated into the design and construction of new libraries or the renovation of existing structures. Following these discussions is a chapter which discusses cost savings that can be achieved with preservation. The discussions emphasize that often preservation will show relatively high capital costs, while providing significant long-term annual savings. The purpose of this discussion is to establish the importance of looking at long-term costs and savings, and working with architects to develop realistic life cycle cost studies and benefit/cost analyses.

The final chapter briefly takes the librarian through the basic steps in new construction (and many major renovation programs), illustrating preservation pitfalls along the way. This section will help ensure that once preservation concerns and issues have been identified and addressed in the building plan they do not disappear as the project progresses. Ways that the library can protect itself and ensure that systems perform the way they were intended are also included in the discussions.

Ideally, the library anticipating renovations or new construction will obtain multiple copies of this publication early in the process. Copies will be distributed by the director to the members of the planning committee and to the library's governing board. This will help ensure that everyone is familiar with why preservation should be integrated into the library design -- and how it can be accomplished. As previously mentioned, the director should ensure that the governing board understands the importance of preservation -- and the broad impact it can have on all areas of the library's operation. The library planning committee should next review this document, highlighting areas of particular concern and discussing different options.

Next, the publication should be given to all architects who are bidding on the project or are otherwise involved. The library should emphasize the preservation issues. The library should also question architects who are suggesting significant deviation from these preservation concerns. For example, if the architect presents plans with entire walls of glass, the library should insist on knowing what steps have been taken to prevent excessive exposure to UV and visible light (as well as the steps taken to reduce heat gain). The amount of time that it will take the library and the architect to "walk through" these various preservation concerns is insignificant compared to the eventual costs if concerns are ignored at the planning level.

It is essential that the library and the architect chosen to plan the new construction or renovation fully understand each other. This publication tries to help by presenting preservation concerns in a manner that the architect can understand, and by presenting design and construction concerns in such a way that the librarian can understand.

What This Publication Isn't

It is also important to clearly state what this publication does not contain and will not do.

This is not a preservation handbook. It does not contain a complete listing of preservation concerns and techniques. There are any number of very excellent texts, pamphlets, brochures, and guides to a wide range of preservation issues. This publication is only concerned with how preservation can be integrated into the construction of new buildings or the renovation of existing structures.

This is not a "scholarly," in-depth guide. It is intended to provide the harried library administrator, planner, or architect with enough information to make sound decisions, not to make them experts in preservation. It avoids abundant footnotes, long lists of citations, and overpowering bibliographies. There are footnotes and citations in the text only where essential. Those seeking more information are referred to the **References and Resources Section**, which offers a few of the many sources of additional information.

This is not intended to be the last word in preservation. It should go without saying that preservation is still a young field and that there are frequent, and often rapid, advances in our understanding. Considerable care has gone into making this guide accurate, well-planned, and carefully reviewed. But there will be advances in preservation that may alter, temper, or void the recommendations offered in this publication. Further, there are certainly areas over which "professionals of good conscience" can disagree. The importance of consulting with professional architects and engineers for specific solutions to specific problems cannot be over emphasized.

This is not intended to be a cookbook approach to preservation. There are many different ways individual institutions can choose to focus their preservation concerns. All building issues have costs, whether they involve the opulence of the director's office or the quality of the air conditioning to be used. These decisions must be made on the local level, weighing a vast number of issues and concerns. The goal of this publication is to help libraries clearly see preservation issues and integrate them into the planning, not to set up an immutable list of requirements.

Ultimately, preservation planning must come from the local library. The library must understand the value of its collections, the importance of those collections to the community, and how those collections are used. The library must set goals and establish strategies for preservation. This document is intended to offer suggestions, not provide commandments.

And finally, this publication is not intended to take the place of design professionals. It should go without saying that reading is no substitute for the professional experience offered by architects and engineers. Their expertise should be sought since there are usually a variety of solutions to any design problem. This publication will only serve as a primer, helping to emphasize the importance of preservation concerns, it will not be adequate to arrive at solutions to every problem inherent in the design or remodeling of libraries.

SITE LOCATION AND PLAN

Introduction

While ideally a variety of preservation concerns should be integrated into the building site selection, typically the location of library construction is somewhat constrained, either by funding, access to property already owned by a governmental entity, or need to reach prospective patrons. And certainly when renovations are being considered, the site location is not an issue. Rarely will preservation concerns and issues be able to influence the selection of a site for the new library. Regardless, it is still appropriate to briefly indicate how preservation concerns might affect the site choice and plan, and how these are often different from the concerns of the architect.

Architects will typically review, if somewhat briefly, such site planning topics as:

- views and existing vegetation,
- slope, soil conditions, and drainage,
- solar energy considerations and the impact of microclimates,
- flood zones, at least from a regulatory standpoint, and
- road access and landscape features.

Urban projects may also include a contextual analysis, examining the building typology and hierarchy, regional character, city form, building scale and fenestration, pedestrian and vehicular access, and various views.

Some of these concerns, such as flood zones, have clear implications on the preservation of the collections. Others, especially the concerns dominating urban projects, are unlikely to be major issues in the preservation of the collections (although they may be major historic preservation issues to which the library has tremendous sensitivity).

In contrast, preservation concerns are going to involve a variety of issues often covered in disaster planning since ***the goal of site planning is to minimize or mitigate as many disaster risks as possible through specific building plan modifications. For those that cannot be minimized, this early planning assists the library in recognizing major issues needing additional internal planning.***

Risk Assessments

Both the first and last step in this process is risk assessment.

In the risk assessment it is important to do more than develop a list of potential problems since this can be almost limitless. Quantifying the risks is essential to guide the development of the disaster plan. A simple technique is based on the formula:

Risk (probability of an event occurring) x Vulnerability (degree of impact to institution) = Criticality

To accomplish this quantification it will be necessary to rely on common sense and experience, but the practice is really simpler than might be imagined.

Scaling of risk and vulnerability are best done using eith. percentages or a 1-4 scale; both are commonly understood and simple to apply. For example, an event which is almost certain to occur is ranked between 76 and 100% or as 4. An event which is highly likely to occur is ranked between 51 and 75%

or as 3. An event likely to occur is ranked between 26 and 50% or as 2. And an event which is least likely to occur is ranked as 1 to 25% or as 1.

Looking at vulnerability, an event that would shut down your library permanently or at least for several months is ranked as 76 to 100% or as 4. An event that would shut down operations for an unacceptable time is ranked between 51 and 75% or as 3. An event that would curtail operations enough to interfere with the functioning of the institution is ranked between 26 and 50% or as 2. Finally, an event which would interfere with normal functions but to a tolerable level is ranked between 1 and 25% or as 1.

The end result of this exercise is the ability to rank concerns, or establish the crucial issues that the planning of the library should face. For example, if both the probability of an event occurring and its impact on the functioning of the library are low, it is likely not a major issue requiring integration into the building plan. There are, however, some issues that all libraries should carefully consider.

Rose and Westendorf[1] provide an excellent list of the multi-hazard ratings of the various counties in the United States. Concerns covered include earthquakes, landslides, expansive soil, flood, storm surge, hurricane, and tornado.

Natural Features

While any list of potential natural disasters could be made to sound like a list of major plagues and disasters throughout history, major concerns certainly include hurricanes, volcanoes, earthquakes, tornadoes, landslides, winds, heat, cold, thunderstorms, and floods. In the Southeast, issues of probable high criticality will include hurricanes, earthquakes, tornadoes, thunderstorms, and floods.

Hurricanes

Between 1900 and 1977 South Carolina was hit by 10 hurricanes, compared to 50 in Florida and 4 in Georgia. The most recent experience in South Carolina with Hurricane Hugo has perhaps reminded libraries that planning for hurricanes is essential. Preservation concerns include accompanying high winds, heavy rainfall, loss of power, and tidal surges.

Architects are able to design hurricane resistant structures, incorporating concerns for construction techniques and specific design parameters, effects of battering, flood minimization, and materials used in construction. One study undertaken in Texas found that complying with model hurricane code provisions would add only about 3 to 8% in structural costs and 1 to 3% in overall finished costs[2].

Excellent data are also available for hurricane-resistant construction that includes features to reduce potential wind damage. The Texas study examined the reduction in damage that would accompany three classes of structures (structures designed to meet a 60 mph criteria, those designed to meet a 105 mph criteria, and those designed to meet a 140 mph criteria). The study found that the relative damage factors for the three classes of structures was 40 to 10 to 1, i.e., 40 times more structures built to the 60 mph criteria and 10 times more structures built to the 105 mph criteria would be damaged than those built to the 140 mph standard when wind damage alone was considered. When flying debris are

[1] Rose, Ralph W. and David G. Westendorf, "Multi-Hazard Ratings of Counties by States for the United States." In *Protecting Historic Architecture and Museum Collections from Natural Disasters*, edited by Barclay G. Jones, pp. 477-528. Boston:Butterworths, 1986.

[2] Lesso, William G., "The Effect on Building Costs Due to Improved Wind Resistant Standards." In *Hurricanes and Coastal Storms*, edited by Earl J. Baker, pp. 109-114. Gainesville:Florida Sea Grant College Report No. 33, 1980.

also considered, the ratio becomes 3 to 1.5 to 1 since it is obviously more difficult to protect against flying boats, billboards, and telephone poles. This study also estimated the average loss per $100 of building valuation for the three classes of structures. These were estimated to be $4, $1, and 0.17¢ respectively.

This study indicates the additional building costs are a small price to pay for the survivability of the library structure and the protection of its contents. Prior to Hurricane Hugo few librarians in South Carolina had been through a recent hurricane. Even now, the number is relatively small. The value of improved construction is realized only when disaster strikes. Then there is either relief or regret.

The architect will, of course, comply with local codes, the most common of which in this region is the *Standard Building Code* issued by the Southern Building Code Congress International, Inc. Differences in designs will often be related to the age of the structure, code enforcement, and the design of structures by non-architects. If hurricanes are a critical concern for a library, it would be appropriate to specifically discuss the level of protection existing codes provide compared to more stringent design features. It may be appropriate to request the architect to design a building which takes into account features not often found locally.

While the architect can handle the building design, the library staff should pay particular attention to features related to the weather-tightness of the building (its envelope, roof, and use of glass), plumbing features such as site drainage, interior drains, and backflow preventers on drains and sewers, and ability to recover. ***The library should be designed to minimize water damage and allow rapid recovery.***

For example, if windows must be included in the design of the library, a protective feature like solid, 1/2-inch plywood window covers should be included. On single story buildings these would be installed from the outside, using pretapped holes in the window frames or "hurricane clips". For multi-story buildings upper level covers could be installed from the interior, again using pretapped holes. When not in use such covers could be stored on site. Light weight covers would facilitate installation by a single individual. Those on the outside could minimize breakage of glass and entry of water and debris. While those placed on the inside might not save the glass, they would at least reduce water entry. The same effect, with greater convenience, can be achieved by installing roll-down hurricane shutters on all windows.

Earthquakes

It surprises most people to learn that the U.S. Geological Survey places South Carolina, the northern half of Georgia and the western half of North Carolina in the same seismic risk zone as much of California. A second area of high seismic risk is located in the Mississippi valley covering parts of Arkansas, Missouri, Kentucky, and Tennessee.

This fact is certainly supported by South Carolina's earthquake history -- the 1886 Charleston earthquake caused damage estimated at $23 million, 60 deaths, and was felt as far as 350 miles away. Two strong aftershocks were associated with the tremor. This was followed by 12 additional earthquakes during the first half the twentieth century.

An earthquake with a magnitude of 4.0 to 5.0 can cause considerable damage. Anything above a 5.0 is sure to result in extensive disruption of library service. An earthquake with a magnitude of 7.0 can destroy buildings and bridges, twist railroad lines, cause floods and landslides, and open large cracks in the ground.

California has made tremendous strides in developing comprehensive earthquake design codes, largely because of its experience dealing with earthquakes and dense concentrations of population that are put at risk. The Southeast has been slow to catch up, and libraries may wish to direct their architects' attention to the California codes such as Title 24 of the California State Building Code, the Los Angeles Masonry Building Ordinance, as well as the Applied Technology Council's proposed seismic provisions in ATC-3. The Recommended Provisions for the Development of Seismic Regulations for New Buildings - 1985, produced by the Building Seismic Safety Council should also be reviewed for design standards.

Structures are damaged or destroyed during earthquakes by four major causes: ground rupture (opening of faults), ground shaking, differential subsidence (sinking of ground areas on faults), and liquefaction (where loose soils are transformed into a semi-liquidified state). Ground shaking, however, is the primary cause of building damage and failure. Earthquakes generate ground motions that can be expressed in three mutually perpendicular axes, essentially at the same time.

Basically, seismic resistance is achieved by combining a variety of structural elements, including continuous shear walls, braced frames, and movement-resistant frames, connected by horizontal diaphragms. It is also achieved by avoiding certain features, such as irregularly shaped buildings and penetrations of the building diaphragm, and using certain types of material, such as tempered glass in all windows.

As with hurricane resistance, the architect will be well able to integrate seismic design features without any assistance from the library staff. The goal of such seismic designs is life safety and to prevent the failure of the structure. Even if a building withstands the earthquake, it can still suffer considerable damage and be rendered nonfunctional because of the damage to nonstructural elements, building equipment, and contents. Further, most seismic designs are not intended to protect building contents. Consequently, library design must be three fold: (1) protection of life, (2) protection of the building, and (3) protection of the library contents. This will call for the use of innovative techniques and a wide variety of design features.

Anything moveable can be affected by an earthquake, including everything from small, lightweight chairs to entire ranges of books weighing hundreds of pounds. Shelving is particularly vulnerable to the effects of an earthquake. Ranges will dump their contents of books and topple into one another like dominoes. Specific earthquake resistive design features include use of lateral bracing and anchor bolts that can withstand the anticipated lateral and uplifting loads and ridge ties at the top of units to brace and stabilize the installation. Shelving against walls should be anchored to the wall to prevent battering. It is essential that shelving not fall over, or even lean, under earthquake forces. An excellent discussion of these techniques is provided by John A. Blume's article, "The Mitigation and Prevention of Earthquake Damage to Artifacts," in *Protecting Historic Architecture and Museum Collections from Natural Disasters* (edited by Barclay G. Jones, 1986, Butterworths, Boston).

Light fixtures are also susceptible to earthquake damage. Suspended fixtures twist and rack with severe damage and failure in the support stems or at the ceiling support points. Surface mounted fixtures often survive undamaged because they are securely tied into the ceiling system. The recessed fluorescent fixtures used in many institutions are often supported on ceiling systems without any positive attachments. During an earthquake these fixtures pound on the surrounding ceiling elements and slide or jump off their supports and fall. Recessed fixtures can be made safer by properly supporting and bracing suspended ceilings, using commercially available attachment accessories, and ensuring the fixtures are secured directly to the main runners of the ceiling support system. Many designers further urge that the fixtures be provided with independent secondary supports attached to the fixture housing and the building structure such as two 12-gauge wires placed on diagonal corners of each fixture. See the June 1992 issue of *Chicora Foundation Research* for additional earthquake guidance.

Tornadoes

Tornadoes are perhaps the most destructive of localized storms. Striking suddenly, their strong winds can uproot trees, lift buildings off foundations, twist structural steel frames, and cut paths of destruction through the countryside. Pressure differentials can cause houses to explode outward. Winds are often in excess of 200 mph, lightning is virtually continuous, rain is very heavy but of short duration, and hail is frequently associated with the storm. The storms typically travel 25 to 40 mph but can remain stationary, change direction, and travel up to 60 mph. Most tornadoes move from the west or southwest toward the east or northeast. The mean width of the path of destruction from tornadoes is 750 feet although this can vary from a few feet to about a mile. While occurring throughout the year, tornadoes peak in April, May, and June. They occur most frequently between 2:00 pm and 7:00 pm.

South Carolina has an average of six tornado days per year, compared to 12 in Georgia, five in North Carolina, 20 in Florida, and 9 in Alabama. Of course, none of these averages compare to the average of 46 tornado days in Texas.

Architects can best protect libraries from the effects of tornadoes through various wind resistive designs. Where warranted, the architect should be requested to specifically design an area of the building suitable as cover in the event of a tornado warning (and this feature should be known by the library staff). Additional preservation concerns will include adequacy of lightning protection, weather-tightness of the building, limiting the number and size of windows, and placement of HVAC equipment on the ground, rather than the roof. Light wood frame buildings and wood frame roofs are particularly susceptible to wind damage.

Thunderstorms

Thunderstorms are most frequent during the warm part of the year, and the lightning which accompanies these storms is perhaps one of the most dangerous of all natural phenomena. During an average year lightning kills more than 150 people, injures over a thousand, and causes in excess of $100 million damage. South Carolina has between 50 and 60 days a year with thunderstorms, compared to around 100 in southern Florida and fewer than 40 in western Texas. The strongest sustained winds on a 50-year basis, excluding tornadoes for the bulk of the Southeast are around 70 mph, while winds of 80 mph can be expected in South Carolina and 100+ mph winds may be found in southern Florida. Most of the Southeast is in an area of relatively heavy rainfall intensity (between 7 and 8 inches per hour for five minute periods expected once every 10 years).

Thunderstorms will primarily damage libraries through the actions of wind and wind-driven water. Consequently, ***it is important the architect consider wind resistant design features (such as the selection of materials which have sufficient strength to resist applied loadings, proper connections, and bracing to resist lateral collapse). An acceptable roof design is equally important. In addition, the librarian should insist on minimizing window exposure, developing good drainage plans for the facility, installing lightning protection, and using both fire detection and suppression systems.***

Floods

Floods are usually divided into riverine floods, defined as an overflow of a river onto the floodplain, tidal floods, defined as an overflow of water onto coastal lands bordering the ocean or marshes, and flash floods, which are local floods of great volume and short duration. To these are added the variety of "floods" resulting from weather conditions, such as thunderstorms, and occasional mishaps such as broken pipes.

The tremendous force of floods should never be underestimated. A flash flood resulting from rain over an area as small as 100 square miles with 12 to 15 inches of rain falling over a 24 hour period can deposit 2½ billion cubic feet of water weighing 78 million tons. Streams flowing at less than a half mile an hour can swell to 35 feet above normal levels and flow at 5 to 10 miles an hour.

The best way to avoid riverine and tidal floods is to locate libraries in areas which are not suspectable to the problem, that is by locating the building in an upland area of inherently low risk. Of course, this is not always possible. Libraries must be built to serve their patrons, which often means locating on floodplains or in coastal flood zones. If this is the case, the first response must be to ensure that the architect designs a building which meets the FEMA building elevation requirements and which integrates special flood resistive features. These typically involve a resistance to flotation (i.e., anchoring the building to the foundation), collapse, and lateral movement. The primary goal of such design is to protect the structure from failure.

The next step would be to ***carefully examine ways to protect the contents of the library***. This protection might be achieved by such steps as limiting windows, promoting site drainage, avoiding collection storage in underground areas, and installing stormwater and sewer backwater preventer valves. Good planning will also ensure there are mechanisms to mitigate the event, should the worst occur. In the event of flooding, these might include such features as floors and walls which can be easily cleaned, and electrical outlets with ground fault circuit interruption.

Man-Made Features

Man-made features are less often considered as a source of vulnerability than natural events. However, a wide variety of issues might legitimately be considered, including proximity to transportation networks that could cause harm to collections, that is, on highways or rail lines used in the frequent transportation of hazardous waste or nuclear material, location near utility plants or lines such as near nuclear or fossil fuel plants or adjacent to substations, or location in neighborhoods that might be prone to violence.

Since at least some man-made hazards can be more easily anticipated than many natural events, one of the easiest approaches is to simply avoid library construction in unsuitable areas. When this is not an option, however, some man-made events offer little opportunity for mitigation. For example, if it is necessary to locate a library on a street frequently used for the transport of nuclear waste, there is little that can be done to design in building safety. The best strategy is for the library to develop contingency plans for such a disaster. Alternatively, if a neighborhood has a history of civil unrest or street violence, additional security designs can be integrated into the planning to provide additional protection to staff, patrons, and collections.

THE BUILDING ENVELOPE

Introduction

The building envelope or "shell" consists of the foundation, floors, walls, doors, windows, and roof. This envelope is the barrier between the controlled internal environment and the fluctuating harsh external environment. The building envelope is also a filter, allowing carefully controlled amounts of light, heat, and so forth into the building. If properly designed and constructed, the building envelope will reduce energy costs.

The preservation of a stable internal environment, essential for the preservation of library materials and of prime concern to most building occupants, is one of the most costly operational items the library must finance. Anything that can be done to minimize long-term costs will be to the advantage of the facility. The library will often find advantage in requiring various cost/benefit and life cycle cost analyses -- items which may have a relatively high initial cost but may significantly reduce operational costs over the long term.

Design Features

The design of an effective building shell begins with the structure's relationship to the site. The more sheltered the site, the easier and less costly it will be to exclude the elements. A low building in the midst of higher buildings is likely to experience lower wind speeds than a tall building situated among low structures -- it is more sheltered. A tall building may suffer from increased heat transfer.

Effective design also considers the structure's orientation. It is important to incorporate controlled uses of the natural climate, while excluding the various disadvantageous features such as high levels of ultraviolet and visible light. Large areas of glass should be avoided on east and west elevations. Windows on the south elevation (if they can be included without compromising the safety of the collections) may help reduce winter heating costs. This, however, also assumes the system is designed to recognize the temperature differential between the north and south sides of the structure. North-facing windows will not significantly increase heat gain, but may cause excessive heat loss in winter. While the sun can never be ignored, in controlled moderation it can be tolerated and even made to assist in the heating of the facility. Left uncontrolled, with a poorly oriented building, the effects of the sun will be disastrous to collections, human comfort, and the budget of the library.

The architect will also recognize that the building shape and weight affect the thermal efficiency of the library building. The smaller the external surface area of the library, i.e., its walls and roof, the less its heat loss. A heavyweight structure, for example, one constructed of concrete rather than wood, will be slow to respond to internal thermal input, but the heat absorbed and stored can be used later to even out the highs and lows, creating a more stable environment than possible with lightweight construction. In fact, a rule of thumb is every inch of brickwork, masonry, or concrete will yield an hour of lag time in heat transmission. Hence a wall 12 inches thick will impede heat flow for about 12 hours -- long enough for the radiation peak to have passed and the exterior temperature to have cooled.

The planner will also do well to eliminate the wasted space of buildings, creating only the space necessary to perform the functions of the library. While "wide-open" spaces may be aesthetically pleasing, they are costly to build and maintain. The funds used for aesthetics could be used to preserve the library's collections. For example, a reduction in ceiling heights to what is necessary (eliminating dead space, atriums and similar design features) can significantly reduce the costs of heating and cooling buildings, without endangering health.

Air leakage (infiltration and exfiltration) are major sources of conditioned air loss and major contributors to fuel wastage. While they cannot be totally eliminated, careful design and planning will minimize leakage. As discussed under **Heating, Ventilation, and Air Conditioning,** a preservation environment will maintain positive air pressure in the building, minimizing infiltration in favor of exfiltration. Essential features include thoughtful planning of internal spaces, careful positioning of doors and windows, selection of windows for high performance, and skillful design of all joints in the building fabric.

In addition to excluding the external environment, the building shell also functions to maintain the often unnatural internal environment such as the cool, low humidity environment in the middle of a sweltering August day or the warm, normal humidity environment in the middle of January.

The design and installation of thermal and vapor barriers is of particular concern when the library is expected to hold constant humidity levels. Many of the condensation and water damage problems in buildings today are the result of architects designing vapor barriers that cannot be built; contractors not understanding the importance of the barrier; and engineers taking a passive role in the design process.

The basics are simple -- every library should have good, continuous insulation. The steel studs frequently used in buildings today act like fins on a radiator, forming a bridge between the inside and outside. The result is that R-19 insulation will be reduced in effectiveness to something around R-10. One solution is to install an insulating, foil-faced sheathing on the winter warm side of the steel studs, carefully taping the joints with foil or plastic vapor barrier tape -- not the cheap "duct" tape often used. This will not only isolate the studs, breaking the "bridge," but will also double as an effective vapor barrier.

Coupled with insulation, as implied above, must be an effective vapor barrier -- one that has a permeance of 0.1 or less perms (grains per hour per square inches of mercury), and that is also continuous. The paper or even foil face of fiberglass insulation does not qualify as continuous and should not be considered an adequate vapor barrier, especially for libraries which will be humidified during the winter. An appropriate vapor barrier is 4-mil high-performance cross-laminated polyethylene film.

Finally, even the best design can be defeated during installation. Vapor barriers can be installed on the wrong side of the wall, forming a "dam," and causing extensive damage to the building, or the vapor barrier can be damaged by later work such as installation of electrical outlets. The library staff should be aware of these potential problems and be alert during the construction of the facility.

There are a variety of very complex and tedious, methods of calculating the thermal performance of a building envelope, taking into consideration the fluctuation of energy input from the sun, the occupants of the building, the lighting and other electrical equipment, and internal heating and cooling cycles.

Normally these are performed **after** the design of the building and are intended to develop the most economical means of heating and cooling, given the building design. It would be to the benefit of the library to request such analyses be performed during the design phase to ensure that the design is thermally efficient. Thermal evaluation at an early design stage can not only save operating costs, but it can ensure a more preservation-oriented structure.

Non-Environmental Features

The building envelope should also be designed with preservation concerns, other than the control of the environment, in mind. For example, by eliminating niches, recesses, courtyards, and other exterior features, the security of the patrons and staff is improved. These measures will likely also reduce maintenance costs.

Both the architect, and later the librarian, should mentally tour the proposed design. Every feature of the building envelope should be examined. No feature should be allowed which encourages vandalism, increases maintenance, or causes other preservation problems. By encouraging careful attention to preservation needs at the design stage, many of the problems typically encountered later in the process can be avoided.

Tips for Renovation

While it may sound as though the approaches offered here are only useful for new construction, there are many improvements that can be economically made in existing building shells. ***If a library is anticipating renovations, the architect should be asked to include recommendations to improve the thermal efficiency of the existing structure.***

One of the simplest steps is to install or replace caulking to close cracks. Special attention should be given to window and door frames, where walls meet the foundation, where walls join at the corners, and around vents, ductwork, pipes, and electrical conduits that penetrate the exterior wall.

Faulty or broken glass should be replaced. Faulty glass can include double pane systems that are foggy, indicating a loss of the vacuum and development of condensation.

Window and door frames should be tightened and carefully weatherstripped. Even little cracks can cause major air infiltration. For example, double doors with no weatherstripping can have an opening of ¼ inch. This amounts to a 20 square inch opening -- over a quarter the size of this page. Installing or replacing weatherstripping will not only reduce air leakage, but will improve the barrier to pests.

Doors and windows that do not operate properly should be fixed. Doors that don't close completely or that have broken hardware should be repaired. All exterior doors should have automatic door-closers installed. They should be checked for proper operation.

Windows can be insulated and shielded. Single pane windows conduct a great deal of heat because their thermal resistance (R value) is very low -- only 0.9. Single pane "storm" windows or double or triple pane replacement windows can double, triple, even quadruple the R-value of your library's windows. Heat transmission can also be controlled with reflective film. Many types also reduce or eliminate the ultraviolet transmission. This film, however, will also block beneficial winter heating, so its use should be carefully evaluated. Windows can be shielded by vegetation (being careful to keep trees away from the building).

It may be possible to add building insulation. Roof insulation, for example, may be applied inside, under the roof, or outside between the roof deck and roofing material. The roof should be the first area examined during renovations since much of a building's heat loss and gain is through the roof. Wherever insulation is added, the library, its architect, and the contractor should ensure the insulation will not contribute to moisture buildup. Vapor barriers and adequate ventilation are essential, but they must be properly installed (discussed above). Where there is concern with condensation in walls, it is possible to use humidity and temperature sensors, within the walls.

It may be possible to create a vestibule in your library which can function as an air-lock, reducing the amount of unconditioned air that enters, and the amount of conditioned air that leaks out. Vestibule areas do not require the use of either air conditioning or heating.

THE LIBRARY INTERIOR

Introduction

Most librarians and architects, when the topics of interior finishes and furnishings are considered, will be concerned with such diverse topics as acoustic quality, durability, creating the appropriate "feel," and aesthetics. The creation of a preservation quality environment is rarely mentioned.

Yet anyone who is hyper-allergic will quickly understand the variety of unpleasant chemicals present in virtually all buildings, especially those recently constructed. One adhesive, for example, was found to off-gas, or release during curing, acetaldehyde, methanol, methyl formulate, ethanol, 2-propanone, 2-propanel, 2-butanone, methyl propionate, benzene, methyl isobutenate, and methylbenzene. An introduction to this problem is John Bower's *The Healthy House* (1980, Carol Communications, New York). Unfortunately, many of the chemicals that affect people are also very damaging to library materials. One of the most troublesome is formaldehyde.

Formaldehyde

Formaldehyde is a colorless gas with an odor detectable at a concentration of about 1 part per million (ppm). At levels of 0.05 to 0.5 ppm eyes may become irritated and at 1 ppm nose, throat, and bronchial irritation is likely to occur. The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) recommends 0.1 ppm as the maximum acceptable level in buildings environment for health purposes.

There is always formaldehyde in the air. Background (or ambient) levels may be as high as 0.02 ppm in an urban setting. ***Sources of formaldehyde are especially prevalent in the built environment, being found in some fabrics, carpeting, particle board, plywood, insulation, paper-based laminates such as Formica®, fiberboard such as Masonite®, fiber-glass molded materials, paints, and plastics.*** It is even found in some paper products, such as paper plates and paper towels. The highest indoor emissions, however, come from two sources -- urea-formaldehyde foam insulation (rarely used today) and wood products, particularly plywood which uses a urea-formaldehyde glue, often associated with interior grade or hardwood plywood. Exterior or marine grade plywood typically uses a phenol resin which is much less likely to degrade and release formaldehyde. Some studies indicate wood bonded with phenol resins emit 10-times less formaldehyde than those using a urea-formaldehyde resin. Most of the formaldehyde emitted by wood comes from the exposed end grains.

Formaldehyde affects library collections in two principal ways. First, in the presence of moisture (even very low relative humidity levels), it will form a weak acid, called formic acid. Formaldehyde also oxidizes to form formic acid. Further, products which contain formaldehyde, also usually contain formic acid. The chemical reaction is particularly noticeable under alkaline conditions, meaning that using alkaline buffering material may actually promote the formation of additional acids in the presence of materials containing formaldehyde. Formaldehyde not only affects the pH of paper, but can alter its color, fade some pigments, and attack the sizing used in some papers.

Since the chemical breakdown releasing formaldehyde occurs even in the cured product, the release of formaldehyde will continue virtually indefinitely. Products 10 years old have been found to still be releasing formaldehyde. Studies have shown emissions increase in the presence of high heat and humidity. Unfortunately, the chemical reaction producing formic acid will occur with relative humidities as low as 20%, so maintaining a "normal" library environment will do little to reduce formaldehyde damage to collections. It is also clear the largest emissions occur during the first few months or year of manufacture. Consequently, using products which have been properly stored after manufacture will reduce the emission levels.

While ventilation is sometimes used to reduce formaldehyde levels, increasing ventilation three to four times will decrease the levels by only one-half. This is a relatively small return for the investment, even if this ventilation level was practical for libraries (which it isn't). In the past sorbants such as gypsum board or calcium carbonate have been used to reduce formaldehyde levels. These items can act as a sink, but they are not a permanent removal system and can become secondary emitters. Even activated charcoal has a very low capacity for formaldehyde. Formaldehyde scavengers, such as ammonium salts, are both impractical and inappropriate for use in library settings.

At least one test found that the application of a polyurethane or polyester finish can reduce formaldehyde emissions by a factor of up to 10 compared with an uncoated sample. The coating, however, must not contribute to the environmental pollution of the library.

Paints and Coatings

The coating of wood-based construction has become common not only for aesthetic reasons, but also to reduce maintenance and improve cleanability. However, many paintings and coatings, are at least as corrosive as the wood they cover. Libraries should carefully choose these materials to enhance preservation efforts, not create additional crises.

Polyurethanes are often used as sealers. The most common type is one with an oil-modified formulation. Terms on the label such as "alkyd resin," "in mineral spirits," or "tung oil," are sure signs of an oil-modified polyurethane. This type of product generates quantities of both formic and acetic acid during and after curing and should be avoided in the library setting. Moisture-cured polyurethanes, which polymerize on contact with atmospheric moisture, form very tough finishes but require strict mixing and are toxic. ***The best choice for libraries appears to be the moisture-borne or latex-type urethanes.*** These generate fewer corrosive by-products, but provide limited vapor barriers. Further, some may contain urea-formaldehyde and should be avoided.

Standard latex paint is not an effective vapor barrier, and the large number of rapidly changed additives may be damaging to some very sensitive collections. ***Acrylic paints are generally safe*** but are not very good vapor barriers. Oil-based paints release a variety of organic volatile materials as part of the drying process. These can be extremely corrosive to many materials and should be avoided.

AFM Enterprises produces a line of Safecoat™ paint advertised as nontoxic and nonhazardous. Pace Industries offers a Crystal Shield™ paint designed to be an environmental sealant. Murco Wall Products, Inc. produces Hipo™, which is advertised as not containing "such volatile compounds as ammonia, formaldehyde, ethylene-glycol, or ethylene glycol butyl ether." Libraries should have their architects investigate the feasibility of using these formulations in place of more common paints.

Formulations are frequently changed by the various manufacturers and ingredients are frequently considered proprietary. If efforts to obtain the necessary information fails, the librarians may need to test paint samples (described below).

Wood Products

As previously discussed, particleboard is never recommended for library construction because of the large quantity of formaldehyde. Likewise, interior grade plywo will often contain urea-formaldehyde adhesives and should be avoided. Most exterior grade plywoods will contain the generally safer phenol-formaldehyde adhesives, although they are rarely of a quality adequate for casework.

Woods, whether used in plywood, or as solid wood, can also vary greatly in acidity (largely related to the acetic and formic acids present). Heat treatments, such as kiln drying, tend to increase the acidity of wood. Heartwoods tend to be more acidic than sapwoods; softwoods are less acidic than hardwoods. Any wood may be the source of volatile organic acids.

Simply put, ***wood is a very poor choice for library furniture and furnishings which will come into contact with books.*** There is no wood which can be safely assumed to be acceptable, and the various coatings and finishings are generally unreliable at sealing the wood to protect the library collections from contact with a great variety of acids and damaging gases.

Metals

Metals have long been the shelving and storage material of choice in libraries. Durable and easily fabricated, they have been thought to present little danger to collections. Typically the metal was protected with a baked enamel finish, improving the durability and offering a supposedly inert barrier between the metal and the material being stored. ***Recently it has been found that when the baked enamel finish is not thoroughly cured, it will emit high levels of formaldehyde.***

Such cabinets or shelving should have no smell. If, upon opening a new microfilm storage cabinet or a box of shelving you detect a chemical smell, it is likely that the finish was not adequately baked and is off-gassing formaldehyde or solvents. Studies suggest light colored shelving will be less thoroughly baked than dark colors. ***Libraries should insist the metals used with a baked enamel finish be thoroughly cured.*** The specifications can be written to require the manufacturer to re-bake the finishes if necessary (paying shipment both ways). Alternatively, the metal shelving or cabinets can be purchased and allowed to air for at least six months before use. Old stock, which has been sitting, and airing, in the manufacturer's warehouse would be an ideal choice.

Recently, some manufacturers, such as Stacor Corporation of Newark, New Jersey, are marketing "conservation quality" metal filing systems. The paint used (a heat-cured acrylic resin modified with a catalyzed melamine in the case of Stacor) is carefully formulated with numerous quality controls and the baking cycle is strictly controlled. The baked enamel finishes produced are superior to commercial grade finishes and are suitable for most library materials.

Another, but often more expensive, alternative is the use of powder coatings which eliminate volatile emissions. The painting process uses an electrostatically applied powder coating of an epoxy-polyester hybrid which is oven cured. Manufacturers using this technique will guarantee the finish is inert. Several manufacturers offer this finish, including SpaceSaver Corporation and Delta Design, Ltd.

In addition to the finish, libraries should ensure the shelving is smooth, free of fittings that could damage collections, and is the correct size for the material being stored. The shelving should be correctly installed and properly cross-braced. The importance of this feature has been previously discussed in regard to earthquake protection.

The use of compact shelving is attracting considerable interest as libraries attempt to store more materials in less space. Major issues include adequate structural support, which can be easily ensured by your architect (and which will be briefly discussed in the following section on floor loads), as well as adequate fire safety. The storage of large volumes of material in compact shelving creates a greater fire load per square foot and makes fire suppression more difficult using sprinklers. A fire safety engineer should be consulted for specific designs. Recent research has demonstrated that carefully selected sprinklers can protect even compact storage when the units are designed to allow some minimal space between them with the sprinklers placed closer together.

Fabrics

The primary concern with fabrics in the library setting is their contribution to the fire load of the structure. But when fabrics are in direct contact with collections, such as in exhibits, they should be selected with additional preservation issues in mind.

Cotton, linen, nylon, and polyester are generally safe, if they are not contaminated with processing chemicals. The less dye and finishing, the safer the fabric will be. Washing in hot water without detergent will reduce the level of additives in most fabrics. Polyester batting is usually safe for padding.

Flame retardants added to fabric may increase the corrosiveness of the material. Its use, however, should comply with the requirements of the local jurisdiction having authority. Beyond that, its use should also be guided by common sense. If the display is designed in such a way as to be a potential fire hazard, it is probably best to redesign the display.

Testing

There are several companies offering testing for formaldehyde concentrations. One is Air Quality Research, which produces the PF-1 Formaldehyde Monitor™ (distributed by Assay Technology in Palo Alto, California). This passive device is hung in the area to be tested for a period of several days, weeks, or months and then returned to the company for analysis. Accurate at very low levels (the optimum sampling range is 0.020 to 1.2 ppm), it is suitable for a variety of preservation needs. It cannot, however, be used in sealed cases, since the monitor operates on the principle of gaseous diffusion and relies on a minimum face velocity across the diffusion path entrance. Failure to provide this air movement would result in an underestimate of the true airborne concentration. Regardless, this is an excellent monitor for libraries seeking to understand exactly what impact formaldehyde may be having on staff and collections.

While the Air Quality Research product provides results in ppm, as a quantifiable test, libraries can also conduct non-quantifiable tests fairly easily. These tests simply alert you to the presence of pollutants that can damage collections. The advantage is that no special equipment is needed and the tests can be done for paints, adhesives, wood, or any other material.

For coatings, the material should be brushed onto a small piece of clean glass, such as a microscope slide. For wood or similar materials, a piece to be tested should be cut or removed from a non-visible area. The sample should be placed in a carefully cleaned, rinsed and dried glass (not plastic) jar. Avoid jars with rubber seal rings or use a piece of aluminum foil to isolate the ring from the jar contents.

Use soft steel wool to clean a piece of lead, such as a lead fishing weight. Do the same with a piece of copper. You may use electrical wire or even a copper penny. A piece of silver (a discarded piece of silver plate found at a garage sale will do) should also be cleaned using a commercial product, then rinsed and dried. Wear gloves to avoid getting finger oil on the clean metals. These three pieces of metal should be placed in the glass jar with the sample.

Finally, place a lightly moistened cotton ball in the jar. It is likely the lid will be metal, so line it with mylar or even aluminum foil, then seal the jar tightly. Place it on a window sill that receives warm afternoon sun.

Prepare a similar jar, without a sample but including the metals, to serve as the control. After a few weeks compare the metals in the jar with the sample to the metals in control jar. Any evidence of corrosion including darkening of the metal or powdery material on the surface on the metals in the sample jar greater than the corrosion seen on the metals in the control jar indicates that the sample is off-gassing. Lead is easily attacked by acetic and formic acids, silver is attacked by sulfur, and the copper will discolor in the presence of amines.

FLOOR COVERINGS AND FLOOR LOADING

Floors and Preservation

From a preservation standpoint, the perfect floor has several characteristics:

- *it does not off-gas any harmful pollutants,*
- *it does not contribute to particulate pollution in the library,*
- *it does not support insect infestation,*
- *it is waterproof or at least water-resistant,*
- *it is fireproof, self-extinguishing, or at least will not contribute significantly to the fire threat (i.e., a Class 1 Interior Floor Finish as defined by National Fire Protection Association 101), and*
- *it is easy to clean.*

Of course, libraries frequently add to this list other requirements, wanting a floor covering that is quiet, will not show soil and stains, is aesthetically pleasing, is easily maintained, will not require replacement, and so on. Naturally, when the list is finished it is likely that no floor covering will meet all of the various requirements imposed on it. Consequently, this discussion will concentrate on preservation issues and allow the librarian, designer, and architect to weigh all of the various concerns to make the final decision.

There are essentially eight types or classifications of floor coverings: concrete, tile/brick/stone, wood, vinyl (including vinyl sheet, homogeneous vinyl tile, and vinyl composition tile), cork, rubber, linoleum, and carpet. The preservation issues associated with each are briefly discussed below.

Concrete may be found as the underfloor in slab construction or as the floor in a variety of multifloor concrete construction techniques. Usually it is covered by one of the other flooring materials since it is often viewed as unattractive, uncomfortable, difficult to clean, and noisy. From a preservation standpoint, concrete (such as slab over precast) is an acceptable finish, if it is sealed to prevent dusting. Often, curing compounds make good sealers.

Tile / brick / stone includes a broad range of materials such as marble, paving bricks, ceramic tile, and terrazzo. All tend to wear well, but are often criticized as being noisy, slippery when wet, and difficult to maintain. All but brick are too hard to "dust" and therefore do not require a sealer. In general, all are acceptable from a preservation standpoint. If correctly installed these materials are waterproof, thereby containing any flooding which might occur, and are non-combustible.

Wood used as flooring will include both softwoods (very rarely used in commercial or industrial settings) and hardwood. It may be applied as strips, parquet, or industrial blocks. Wood is typically criticized as being noisy and difficult to maintain, especially in high traffic areas. To these are added the preservation concerns of adhesive off-gassing (in the case of parquet and blocks), water retention during flooding, and combustibility.

Vinyl is a commonly used flooring material for libraries. It is less expensive than cork, rubber, and linoleum, although it is often slightly noisier (if no felt backing is used).

Glare may be a problem with some vinyl and these floors are often criticized as appearing "institutional." Some vinyl materials have very high load limits (approaching 200 psi). The major preservation concern is the off-gassing of adhesives used to install the vinyl.

Cork has excellent noise reduction capability and is comfortable. However, it is difficult to maintain, relatively expensive, and generally, lacks durability. Preservation concerns include primarily the adhesive.

Rubber floorings offer good resistance to wear, and are comfortable and quiet. They are considered very durable, even in high use areas. They should not be used in direct sunlight and they do require some specialized maintenance. Rubber floorings give the impression of industrial activity, rather than opulence. Preservation concerns center primarily on the composition of the flooring, the adhesives used with the tiles, and the smoke that might be generated in case of a fire. On the other hand, if quietness is a major concern, this material may be an acceptable compromise.

Linoleum, once found in many institutional settings, is rarely seen today. Although inexpensive and relatively comfortable, it is not considered quiet, offers few color choices, and requires extensive maintenance. Preservation concerns include primarily the adhesives used to lay the tiles.

Carpet seems to be a common choice in libraries today, largely because of its perceived acoustic quality, range of colors, and ability to create a luxurious atmosphere. In spite of these (and perhaps other) benefits, there are better preservation choices.

The adhesives typically used for installation may off-gas a variety of volatile organic components (VOCs) and formaldehyde, as do some carpets themselves. If carpet must be used, librarians should insist that the chosen carpet compiles with the voluntary Carpet and Rug Institute's testing and labeling program. Carpet that meets the predetermined emission criteria is identified by a green, indoor air quality label on the back of the product. While this will not guarantee the carpet is free from formaldehyde, it will indicate that it meets certain minimal standards.

The gradual breakdown of carpet fibers will contribute to the particulate load in the library, particularly if maintenance is minimal. Natural-fiber carpets are an attractive food source for many insects. Even synthetic carpets or those treated with "moth-proofing" provide excellent refuge and harborage for fleas and other insects. In the event of a flood, carpets will hold a tremendous quantity of moisture, elevating relative humidity levels and promoting mold growth. In multistoried buildings carpets will offer no containment of water in the event of leaks. Carpets can be made fire retardant, and if used in a library this characteristic should be a criteria of selection. Finally, carpet cleaning is problematical.

Although maintenance staffs typically claim carpet cleaning is easy with a vacuum, this cleaning is effective only if done routinely, and using an appropriate vacuum. Otherwise, little is accomplished beyond dispersing the soil throughout the carpet and into the air. Manufacturers' claims concerning durability are usually based on a strict regimen of cleaning. Few libraries have the staff to daily vacuum all carpeted areas. The reduction in maintenance which characterizes many libraries today is likely to affect carpet more seriously than other flooring materials.

Eventually carpets will need to be deep cleaned. This is a difficult undertaking requiring special equipment. Shampooing will introduce high relative humidity levels into the library and must be done when the carpet can dry without traffic.

Typically, planners do not recommend the use of underlay with carpet in libraries because of the increased difficulty rolling book carts and wheelchairs. However, many of the benefits of carpet such as noise reduction and durability are reduced if no underlay is used.

Librarians should realize that the noise reduction qualities of carpet are relatively small, compared to a variety of other possible acoustical design features. In particular, good quality acoustical panels often have a noise reduction coefficient of .80 to .95. One such panel is the Eckel Industries Textured Functional Panels (TFPs) or Acoustic Lay-In Panels (ALPs) which have noise reduction coefficents of .99+. The careful design of the library, using techniques to absorb and block unwanted noise, as well as careful attention to the direction and distance of potential noise sources, may eliminate the perceived acoustical benefits of carpet, definitely benefiting the preservation of the collections.

Floor Loading

Floor loading is a complex topic that is best handled by structural engineers. However, it is essential that architects understand the peculiar nature of library loads. Books, when stacked together, are heavier than one might imagine. "Normal" books weigh 25 to 30 pounds per single run of a 3 foot shelf three-quarters full. Bound periodicals in a similar setting will weigh around 55 pounds. Averaging the two, a seven shelf, double-sided stack run 18 feet long with 3 feet between ranges in a 22½ foot grid square will weigh between 25 pounds per square foot and 55 pounds per square foot (books alone, not including shelving weights). There will be wide variations in these loads, depending on local conditions, and this is offered simply to demonstrate that libraries are very different from other types of structures, at least in the calculation of imposed or live loads.

Many architects recommend that libraries have structural systems capable of supporting live loads of 150 pounds per square foot for regular stack areas, 300 pounds per square foot for compact shelving, and 500 pounds per square foot for map/microform bulk collections. This clearly demonstrates the tremendous variation in library materials and their storage.

Typically, architects will not design entire structures for any one live load, much less the maximum load, unless specifically instructed to do so. It is therefore essential that the library develop long-term plans prior to the design phase, considering the possible future use of compact storage of collections and the need for future flexibility of storage areas.

At a minimum, it will be useful to obtain, in writing, the live load calculations used by the architect for various areas of the building. This information will make it possible to determine in the future whether the structure will tolerate planned movement of collections or installation of new shelving without the cost of an additional evaluation.

It is also important to realize if compact shelving is being used, or being considered, fire protection and ventilation are critical concerns. It is possible to design adequate fire protection for compact storage, but detection devices must be carefully chosen, sprinklers must be placed closer together, and it is beneficial to leave slight openings between the compact shelving units to allow water penetration. This space will also improve ventilation and reduce problems of mold and mildew[1].

[1] LaFollette, Larry L., "Help: We Can't Breathe in Here: The Effects of Limited Air Circulation Within Mobile Shelving Units," *Records Management Quarterly* (April 1991):24-27.

ROOFING

Introduction

It may surprise librarians to learn the roof is actually a low percentage of the total square foot cost of a structure. In spite of this, water penetration is usually the major problem in building construction and maintenance. One of the best ways to protect collections from water damage is to ensure the integrity of the roof. The process of protecting collections begins at the design stage when the roof type is selected, continues into construction when the selected roof is installed, and finally relies on appropriate maintenance. If proper care is taken in the selection, design, and construction of the roofing system, much time, money, and aggravation will be avoided later.

Roof assemblies must be designed to resist a number of forces, including water, heat, ultraviolet radiation, traffic, differential movement, wind, snow and ice accumulations, fire, and water vapor penetration. In addition, there are related materials that must be included in the consideration of roofing, such as flashing materials, gutters, roof deck insulation, roof hatches, and skylights. Any one of these can allow serious water penetration and can result in the failure of the roofing system. Consequently, the system selected should be one that:

- ***has demonstrated performance in the area where the building will be constructed,***
- ***has a long life expectancy when properly installed,***
- ***is low maintenance, and***
- ***has local support (i.e., at least one qualified local contractor who can make future repairs).***

Roof assemblies consist of basically two components: a substrate or **deck** which is designed to resist vertical and horizontal loads and the **roofing** which is designed to form a barrier against the elements. The assemblies may be either **pitched** (or sloped, typical of most residential construction) or **flat** (typical of most commercial and industrial construction.

Pitched or Flat Roofs

There is a myth among many librarians that pitched roofs are less prone to leaking than flat roofs, perhaps because a pitched roof will obviously shed water while many people believe that a flat roof will retain water. While individuals perceive that residential pitched roofs have relatively few leaks, many libraries with flat roofs have horror stories of water damage.

The problem with this comparison is most home owners do not avoid the relatively low maintenance associated with their pitched roof, while libraries (or their governing authorities) often delay essential maintenance or even roof replacement. As a result the failure of flat roofs stems from inadequate attention, not necessarily from design.

When properly designed and constructed, flat roofs are not flat. They are typically designed with adequate slope to promote positive drainage and avoid ponding (or the creation of small, poorly drained bodies of water on the roof). Flat roofs are provided with drains, located at low points and sized to ensure rapid run-off of water. When the roof also has a parapet, scuppers must be provided to provide drainage in case the drains become clogged. It is helpful to locate scuppers where they are visible; if the scupper is discharging water the drains are clogged and need immediate attention.

With attention to selection, design, installation, and maintenance, there is no appreciable difference between the weathertightness of a pitched and a flat roof. Either one will serve adequately for a library.

Types of Roofing

There are essentially four types of roofing commonly available:

- shingles (either metal, slate, tile, wood, or asphalt),
- metal sheets or panels,
- single ply or membrane, and
- built-up.

Shingles

Shingles are watershed materials, meaning that they are not intended to retain water, only to direct it by means of the roof slope. Consequently, shingles usually require a pitch of at least 3 inches per foot (normally 4 inches or more) and are not installed on flat roofs. Whether metal, slate, tile, wood or asphalt, shingles typically consist of overlapping or interlocking units of a generally small size.

Slate and tile roofs are rarely used in library construction because of the cost involved and the craft level of skill required for proper installation (the cost of a square[1] of slate, installed, is approximately $700, the cost of clay tile is approximately $500, compared to about $300 for asphalt shingles). In addition, these materials typically weigh two to three times that of asphalt shingles, requiring more careful design of the roof system. In spite of these drawbacks, good tiles or slates may have a serviceable life of 60 to 100 years, far exceeding that of other materials. Consequently, the initial cost of slate and tile roofs may be offset by replacement and maintenance costs usually associated with other roofing systems.

Wood shakes also are rarely used, in spite of similar installation costs to asphalt shingles because of their lower fire rating and greater water vapor penetration.

Asphalt shingles include those with an organic felt base and those with a fiberglass base. The life span of organic felt shingles is shorter than fiberglass shingles which have a rated service life of about 20 years. The fiberglass shingles do not absorb moisture as readily as organic felt shingles and therefore provide better resistance to moisture penetration. Fiberglass shingles also typically have a higher fire rating (UL Class A rating) than organic felt (UL Class C) shingles. A heavy grade of shingle (at least 330 lb.) is essential for library construction.

There are metal (primarily steel and aluminum) shingles with a service life exceeding asphalt shingles. Costs are only slightly higher. Some come in prefabricated panels, reducing the cost of installation. Many can be applied over asphalt shingles during renovation (assuming that the roof deck can support the additional weight).

Where shingles are to be used, the library should carefully consider the use of either slate or tile because of the long service life of these materials and the low maintenance. Where the initial costs of slate or tile cannot be carried by the building program, but shingles are desired, the next choice of material should be metal shingles. Finally, fiberglass shingles can be used. Libraries should avoid organic felt asphalt shingles, as well as wood shakes.

Metal Sheet Roofing

Metal roofing systems may be divided into two groups: preformed and formed. Preformed metal roofs include materials such as aluminum and steel sheets often used on utility and storage buildings. Preformed metal roofing materials are generally not used in

[1] A "square" is a term used to describe 100 square feet of roof area.

library construction.

Formed metal roofing is found on sloped roofs that are covered with some base or decking material such as plywood. Typically this type of roofing is more aesthetic than economical, costing three to eight times asphalt shingles. Offsetting these costs may be the longevity of this roofing material which can last anywhere from 20 to 100 years, depending on material, installation, and maintenance. Typical materials include copper, lead, and zinc alloy. Flat sheets are joined by tool-formed batten-seam, flat-seam, or standing-seam joints. Solder or adhesive is subsequently applied.

Libraries considering the use of metal sheet roofing should expect the higher cost since that is usually associated with a higher grade of material (i.e., 20 oz. rather than 16 oz. copper, .040 inch rather than .020 inch zinc alloy and so forth). The library should ensure that the roofing is attached in such a way to withstand severe winds.

Single Ply or Membrane Roofing

Single ply roofing includes primarily elastomeric materials although there are both modified bitumens (MB) and reinforced modified bitumens (MB/R) that are used in re-roofing existing membrane roofs (see below).

As the name implies, this type of roofing forms a continuous membrane or covering over the entire roof deck which is typically "flat." Some types are applied loose-laid and ballasted with gravel (the most economical), while others are either partially or fully adhered to the roof deck. Only mechanically fastened, fully adhered roofing is recommended in high wind areas.

Elastomeric roofing includes a wide range of materials such as EPDM (ethylene propylene diene monomer), neoprene (polychoroprene), CSPE (hypalon or chlorosulfonated polyethylene), and CPE (chlorinated polyethylene). Each type has advantages and disadvantages. For example, hypalon is very resistant to ozone and superior to neoprene in resisting ultraviolet radiation, heat, and abrasion. It is also not combustible. Since it cannot be applied over an existing asphalt membrane roof, its use is limited in re-roofing applications.

The life span of this roofing is around 20 years and the cost ranges between $3 and $7 per square foot ($300 to $700 per square; the lower end of this scale is roughly equal to that of high quality asphalt shingles on a pitched roof).

Failure in membrane roofing can usually be traced to a limited number of problems. Perhaps the most common is improper selection, design, or installation. Strict adherence to the manufacturer's recommendations is essential. Penetrations made in flat roofs for vents, skylights, and HVAC equipment should be minimized, and should follow carefully the manufacturer's recommendations. The next most common source of problems is the treatment the roofing material receives after installation. The membrane can be punctured by heavy equipment and construction debris. Identification of these holes, often no larger than 1/16-inch, can be both difficult and time consuming.

A library anticipating a flat roof using elastomeric roofing should discuss a number of specific issues with the architect, including:

- the use of only mechanically fastened, fully adhered membranes,
- the roof's resistance to weathering and air pollution,
- the tensile strength and "crack-bridging" capacity of the various materials,
- water vapor transmission,
- resistance to impact, puncturing, and foot traffic, and

- effects of deck imperfections.

Built-Up Roofing

A built-up roof is composed of three different and distinct elements: felt, bitumen, and surfacing. The felts, which are typically made of fiberglass or organic material, serve much the same purpose of reinforcing rods in concrete, providing tensile strength to the roofing material. Applied in layers, the felts also allow more bitumen to be applied, increasing the waterproofing ability of the roof. The most common built-up systems available contain 2, 3, or 4 layers of felt. Bitumen, either coal-tar pitch or asphalt, is both the waterproofing and also the "glue" that holds the roofing material together. The surfacing may be gravel, slag, or a mineral-coated cap. Regardless of exact material, its function is two-fold: to protect the bitumen from attack by solar radiation and chemical oxidation (providing a "wear-surface") and to provide a fire-retardant coating.

It is particularly essential in built-up roofing that adequate drainage is provided. Water that is allowed to pool, or pond, on the roof will cause premature breakdown of the organic felts, blistering, and may loosen the protective aggregate. Standing water on built-up roofing will significantly reduce its life span and should be carefully avoided.

The life span of carefully applied built-up roof systems is typically 20 years, while those of inferior quality may last as few as five years. The cost of a well constructed roof may be about $200 per square.

Considering cost and service life, built-up roofing is an economical choice, which certainly accounts for its wide-spread use on commercial and industrial buildings. Failures of this type of roofing are more often related to improper installation than to the materials used. If built-up roofing is to be used by a library, several precautions should be taken:

- at least three and preferably four fiberglass felts should be used,
- any voids under the roofing should be provided with ventilation to prevent interstitial condensation,
- roof voids should be protected from warm, damp air rising from the occupied space through the use of vapor barriers,
- the roof should be carefully insulated since flat roofs have the greatest heat losses in winter and heat gains in summer,
- special care should be taken to insure adequate detailing around flashings, upstands, parapets, and so forth,
- installation should avoid trapping moisture between felts or the deck and roofing, and
- careful attention should be given to proper drainage of the roof surface.

Roof Drainage

While roofing materials are intended to either shed water (singles) or provide a waterproof membrane (single-ply roofing), some provision must always be made to transport water off the roof and away from the building. On pitched roofs this is accomplished by adequately sized gutters and downspouts which transport the water at least 10 feet away from the building and preferably into a storm water drainage system.

On "flat" roofs this drainage is accomplished by roof drains with piping sometimes located within columns. While this approach often reduces construction costs, it should be avoided since drains located near (or within) columns may turn out to be at high

points since there will be no deflection in these areas. Likewise, drains at the midspan of framing will be inappropriate if the framing members have been fabricated with an excessive camber. Typically, small, but more closely spaced drains are preferable to fewer, but larger drains.

ELECTRICAL AND PLUMBING CONCERNS

Electrical Issues

The single most important preservation issue in planning electrical service for new library construction or renovation is the strict compliance with the National Electrical Code of the National Fire Protection Association (latest applicable, NFPA 70-1993). If local jurisdictions do not have an electrical code the library should insist the NEC provisions are followed, both for the safety of staff and patrons and for the safety of the collections.

Several code-related issues are of special importance. The first is the use of Ground-Fault Circuit-Interrupters (GFCIs). Typically required in bathrooms, garages, outdoor receptacles at grade level, near water sources, and so forth, they are intended to disconnect the power supply swiftly enough to prevent accidental electrocutions. In addition, they reduce the fire risk.

Under flood disaster conditions it may be necessary to use wet vacs, fans, dehumidifiers or similar electrical equipment in the library structure (particularly in the stacks). Consequently, ***the library should ensure that GFCIs are provided on a large number of 15- and 20-amp outlets, especially in stack areas.*** This will help ensure the safety of library personnel during disaster recovery operations. If all outlets are not GFCI equipped, those which are should be clearly marked and the staff should be educated about their use.

A second major issue is the clear and central location of the main electrical service disconnect. All electrical service is provided with a point at which the conductors within the structure can be disconnected from the service-entrance conductors. This location should be clearly marked, accessible to the staff (but not patrons), and should be clearly marked with disconnect instructions.

A third issue is the clear marking of all circuit breakers in the various panels. This is essential if the staff is to respond to limited disaster situations, such as localized flooding or structural damage. The electrical contractor should have this task clearly outlined in the bid package.

A fourth issue is the need for emergency power. Large scale emergency power using standby generators is typically beyond the budget or need of small libraries and power for various emergency signage and lights is typically provided by rechargeable batteries. Even small libraries can afford the new generation of uninterruptable power supplies (UPS) for computers and similar essential electronic equipment. A well-designed UPS will continue to provide uninterrupted computer-grade power when utility power fails; continuously clean raw utility power to prevent damaging sags, spikes, and surges; dynamically respond to load changes; provide spike and noise attenuation; and handle start-up surges. The new UPS have ferroresonant transformers and are dual track (one example is the Micro-Ferrups® produced by Best Power Technology, P.O. Box 280, Necedah, Wisconsin). These can be either hard or soft wired, but the library should determine exactly what its needs are early in the planning process.

A fifth issue of vital concern is the use of polychlorinated biphenyl (PCB) dielectric fluid in transformers and capacitors. Found today primarily in older equipment and buildings, PCBs are highly toxic and long-lasting, suspected of causing a variety of birth defects, cancer, liver damage, and other diseases. The Environmental Protection Agency regulates the use of PCBs and labeling of both new and existing equipment containing dielectric fluid in the provisions of 40 CFR 761 (Figure 2). If contained, the PCBs pose little hazard. The most serious threat is during a fire PCBs could be spread throughout the library, contaminating both the building and its contents (an example of such a disaster was the February 5, 1981 explosion and fire in the New York State Binghamton building).

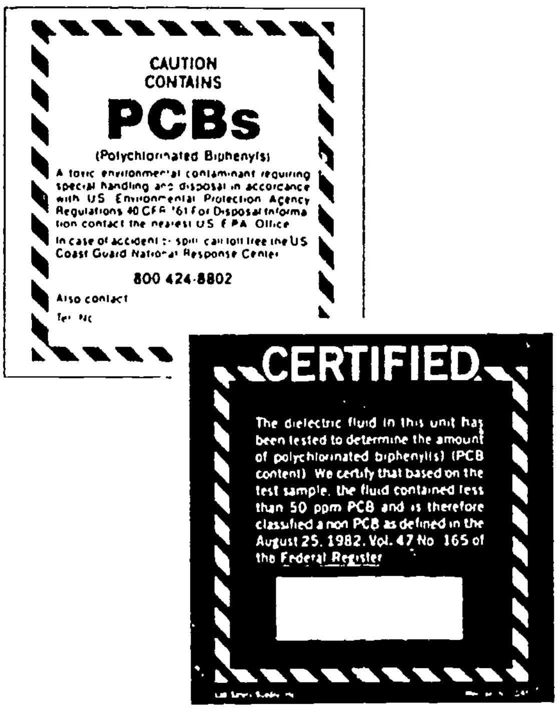

Figure 2. Examples of PCB signage.

A final issue that is often overlooked is the need for ***surge and lightning protection.*** The entire Southeast is at risk of lighting strikes that can destroy sensitive equipment, damage structures, cause fires, and place patrons and staff at risk. South Carolina averages 50 to 60 days a year with thunderstorms, while southern Georgia averages 70 and parts of Florida average 90 to 100. A lightning protection system is an integrated arrangement of air terminals, bonding connections, arresters, splicers, and other fittings installed on a structure in order to safely conduct lightning discharges to the ground. Such systems should be listed by Underwriters Laboratories and are covered by National Fire Protection Association 78: *Lightning Protection Code.*

Plumbing Issues

This section might be more accurately entitled "Concerns with Water" since plumbing technically covers only water distribution systems and our concerns are somewhat broader. In fact, they begin with the siting and landscaping of the library structure.

Too often such buildings are semi-subterranean, leading to immediate problems with water seepage, high moisture levels, and mold growth. If the preservation concerns are overwhelmed by aesthetics or energy issues, then the library must ensure that the building is adequately protected from moisture. Failure to do so will result in a series of other problems that will have major cost implications.

Dampproofing is a below-grade surface coating intended to reduce the migration of moisture. It is not effective when there is hydrostatic pressure. Typically, the deeper the structure, the greater the hydrostatic pressure. Waterproofing prevents the entry of water that is under pressure by forming a continuous membrane around the walls, through footings, and under or within concrete floor slabs. Waterproofing will include dampproofing; however, dampproofing never incorporates waterproofing. One example of waterproofing is the Tuff-N-Dri® system by Owens Corning Fiberglass. This system consists of a polymer-modified asphalt spray applied to the exterior concrete and a combination insulation and drainage board placed against the membrane. This board also serves to protect the membrane from backfilling (Figure 3).

A number of serious moisture problems in libraries can be traced back to inadequate concern for waterproofing and/or the failure of various corrective efforts. When an adequate waterproofing system has not been provided, has been improperly applied, or has been damaged (perhaps during construction) the solution will require extensive and costly work. Often it will be necessary not only to excavate around walls to install, or re-install, waterproofing, but it will also be necessary to construct French drains to reduce the hydrostatic pressure.

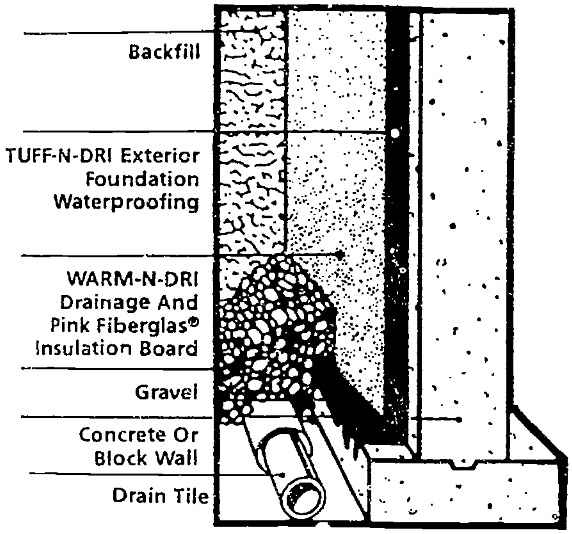

Figure 3. Example of a waterproofing system for basements.

The grading—plan should also be carefully reviewed by the library. Make sure the exterior surfaces slope away from the building (many architects recommend at least a 1% slope away from the building). Avoid any plan in which the ground surface is either level, or actually slopes toward the structure. There should be exterior area drains (typically closed drains in an urban setting) connected to the stormwater system that cover any low areas and access points to the structure. Grates should be designed oversize to prevent the buildup of water and for a safety margin on the commonly used "clog factor." Libraries rarely have adequate maintenance staff to ensure that drains are always free of debris. Oversizing drains in the planning process is much less expensive than either additional maintenance staff, or disaster recovery when the institution is flooded.

Moving into the structure, one of the first concerns should always be the location of water and waste water pipes. ***Pipes (other than those associated with fire sprinkler systems) should be avoided in the collection and other sensitive areas.*** This can be accomplished by requiring specific routing be developed early in the planning process, rather than allowing the routing to be determined by the plumbing contractor.

If specific routing cannot totally eliminate piping in collection areas, there are several choices that should be examined by the institution:

- double-walled pipes often provide an extra degree of safety. These are likely to be beyond the resources of most libraries, but they should be considered.

- water pipes can be routed along walls, rather than directly overhead. This approach may help to minimize damage in the event of a leak.

- protective aprons can be installed under pipes to channel the water to a drain or away from books.

- the institution can install various water alarms or leak detectors in areas suspectable to leaks and damage. One example is the Water Alert® by Dorlen Products, 7424 W. Layton Avenue, Milwaukee, Wisconsin 53220. These can be used singly, or wired to a central alarm station. Dorlen also distributes the Ceiling Guard®, which is used to detect water leakage in false ceiling areas.

- coupled with these other approaches (and certainly absent any other approach), the institutionshould re-emphasize the importance of installing all shelving a minimum of 4 inches off the floor (this approach also aids in cleaning and pest control) and using canopies over all ranges.

Related to the use of overhead space for water pipes is the frequent condensation associated with these pipes (most often cold piping operating below the ambient dew point in institutions with inadequate dehumidification). Occasionally this problem will also be associated with uninsulated metal HVAC ducts. While often this problem results in little more than occasional inconvenience and stained ceiling tiles, it can substantially raise the relative humidity, damage collections, and cause other problems. The solution is to ***ensure adequate insulation, vapor barrier, weatherproofing,if necessary, and appropriate hangers for all pipes and ducts.***

The library should be sited so that sump pumps are unnecessary. However, if such pumps are needed, fail safe features must be designed into the plan. The pumps must be adequate to handle the worst expected case, emergency electrical power should be provided, and redundancy should be designed into the system.

Just as it was important to clearly mark electrical disconnects, ***it is essential to mark both the exterior (street) disconnect valve, as well as the interior disconnect valve.*** While

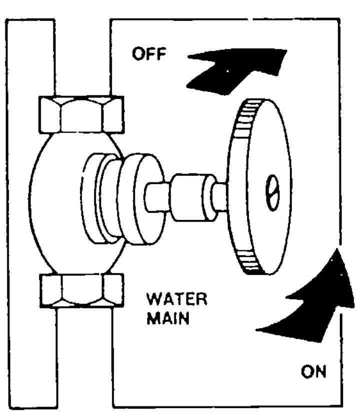

Figure 4. Example of water disconnect signage.

ideally all staff members will be trained to disconnect the water, signage should be installed providing simple instructions (Figure 4). City water disconnects are independent from sprinkler main controls, and while the staff should know the location of the sprinkler main, this system should never be turned off except by authorized repair firms and the fire department.

There are a number of additional water sources in a building. For example, the HVAC system will produce condensate (and some systems may use chilled water for cooling and hot water for heating and dehumidification). ***Consequently, all mechanical rooms, rest rooms, janitor closets, and hot water tank storage rooms should have floor drains, the floors should be designed to be waterproof, and floors should slope toward the drain. All interior drains should be equipped with a backwater preventer valve.*** This will prevent backflow of water into the facility. In high risk areas such as mechanical rooms, it may be appropriate to install a curb around the rim of the room, including the door area, to contain any water in the one room.

Sewer cleanouts are always necessary, but they should be located, if possible, outside the building. They should never be located within the stacks or in special collection areas.

All spigots, both those outdoor for landscape work and those inside for maintenance purposes, should be secured from vandalism. Handles may be removed, which will eliminate opportunistic vandalism, but not more determined individuals. Alternatively, the spigots can be installed in lockable boxes. This latter approach provides more security, assuming that maintenance staff lock the boxes after each use.

Additional Concerns

Additional electrical and water concerns are discussed in the sections on fire safety (sprinklers and fire hoses), security (power failures), roofing (weather proofing), and pest control. These sections should be consulted for additional information.

INTERIOR LIGHTING

Introduction

Lighting is basic to the design of new library facilities since it not only allows objects to be seen, but also exerts psychological influences on staff and patrons. The designer will be concerned with a wide range of topics, including reflective and direct glare, contrast, color rendition and temperature, reflective qualities, intensity, and color constancy. These issues include aesthetics, scale, shape, energy consumption, life expectancy, ease of cleaning, availability of replacement parts, and cost of replacement of various fixtures used.

Turning first to light, the electromagnetic spectrum includes visible light or white light in the center, with infrared or IR at the upper or right end (with long wavelengths) and ultraviolet or UV at the lower or left end (with short wavelengths) (Figure 5). It is important to understand that while unfiltered daylight includes all of these wavelengths in some proportion, different types of lamps produce different spectrums. Hence you have "cool" fluorescent tubes which emphasize the blue end of the spectrum and "warm" fluorescent tubes which emphasize the red end of the spectrum.

Illumination may be measured in either footcandles or lux. The approximate conversion is:

1 footcandle = 11 lux, or
1 lux = 0.09 footcandle.

A footcandle is defined as one lumen per square foot, while a lux is defined as one lumen per square meter. Measurements can be made using a light meter designed specifically for such work, reading in either footcandles or lux. Alternatively, a camera with a built-in light meter can be pressed into service for approximations (see Appendix I).

Since UV is a component of visible light it is common to measure UV as a proportion of total light, or as microwatts per lumen (μw/lumen). At the present time there is only one instrument manufactured that provides reasonably reliable UV levels -- the

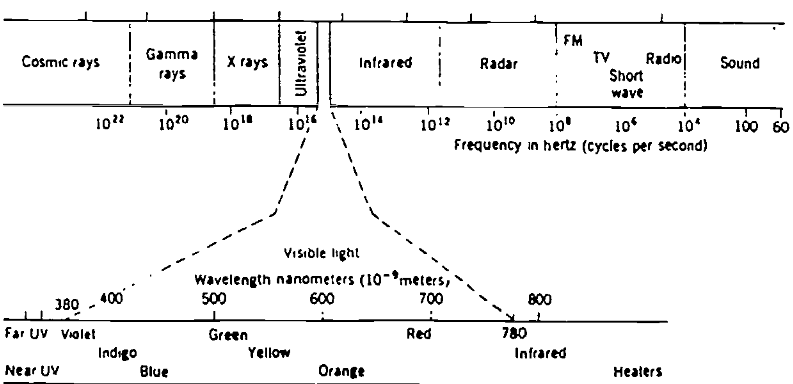

Figure 5. Electromagnetic spectrum (adapted from Benjamin Stein, John S. Reynolds, and William J. McGuinnes, *Mechanical and Electrical Equipment for Buildings*, Seventh Edition, 1986, John Willey & Sons, New York.)

Crawford UV monitor (manufactured by Littlemore Scientific Engineering Co., Railway Lane, Littlemore, Oxford OX4 4PZ, England).

Turning from light to the various sources and fixtures, the design of lighting fixtures is almost limitless. There are, however, basically four light sources used for interior lighting: daylight, incandescent, fluorescent, and high-intensity discharge (HID) lamps. For a variety of reasons, the most common are daylight and fluorescent.

The ordinary domestic electric light bulb is referred to as the incandescent or tungsten lamp. Typical UV emissions are 60 to 80 μw/lumen, establishing a standard for other lighting. Tungsten lamps are short-lived, produce a relatively harsh light, and are expensive to operate and replace. An adaptation is the tungsten-halogen, or quartz-halogen. More efficient and producing a whiter light, this lamp also produces very high levels of UV (upwards of 130 μw/lumen with a glass filter). Incandescent lamps produce relatively large amounts of heat (for example, 94% of the electricity used with a 100 watt tungsten bulb is converted into heat, only 6% is converted into light).

High-intensity discharge (HID) lamps, including mercury and sodium vapor lamps, are typically not used for interior lighting because of their poor color rendition although the new generation mercury lamps have significantly improved color rendition. Metal halide lamps have better color rendition and are occasionally used in libraries. All HID lamps produce very large amounts of UV radiation (400+ μw/lumen) and must be carefully filtered for interior use. Like tungsten-halogen lamps, metal-halide will produce a significant rise in temperature which can be damaging to collections.

Fluorescent lamps are probably the single most common lighting element in libraries. While they are cooler than the other lamps, they too generate heat especially the control equipment or ballast. UV emissions from fluorescent lamps range up to about 650 μw/lumen, although most produce about 100 to 200 μw/lumen.

Recently, a "new" type of lamp has been developed which may find use in libraries -- the E-Lamp or Electric Lamp. While looking like an incandescent bulb, it will actually operate more like a fluorescent lamp. Benefits include a long life (perhaps 30,000 hours), no flickering or buzzing, and a warm yellow color. Unfortunately, it is likely that these bulbs will also be high emitters of UV rays. Libraries should be very cautious in the use of these new bulbs.

The Threat

Since light is also physical or radiant energy, it causes the deterioration of virtually all organic materials. Many dyes and pigments will fade over time with exposure to light. Paper, microfilm, and other materials will deteriorate. These effects are noticed in the library as furniture fabrics and carpets fade, book bindings, especially spines, fade, paper yellows and becomes brittle, artworks fade, and wall coverings yellow. The cost to the library involves early replacement of books, and increased maintenance of the building and its furnishings.

In 1952 the National Bureau of Standards published a study that estimated the level of damage to low-grade paper caused by the different parts of the spectrum or wavelengths. In general, the study found there is an exponential increase in damage as the wavelength becomes shorter toward the ultraviolet end of the spectrum.

While all light is damaging, UV is significantly more damaging to library materials than other sources. Natural light is of particular concern since it has an extremely high level of UV component compared to other lighting sources. For example, the UV light in a blue sky is about 1600 μw/lumen. Even the light from a cloudy or overcast north sky can contain 800 μw/lumen of UV radiation. "Safe" lighting from an ordinary tungsten light emits from 60 to 80 μw/lumen of UV light, and fluorescent lights produce around 100 to 200 μw/lumen of UV radiation.

Light damage is cumulative and it is the total dose or exposure matters in the preservation of collections. Put very simply, one hour of exposure to bright daylight with 1600 μw/lumen of UV produces the same damage as 32 hours exposure to a light producing 50 μw/lumen UV. Or 100 lux of visible light for 8 hours will produce the same damage as 50 lux for 16 hours.

In the final analysis, UV only increases the damaging effect of light. Even if a perfect UV filter existed to eliminate all of the UV rays, light would still produce noticeable damage to many collections and building contents. One study found that UV filtered daylight was three times as damaging as an equal amount of light from an tungsten lamp.

Therefore, a conservation environment for light sensitive materials is established to reduce visible light to 50 lux and UV radiation to no more than 75 μw/lumen. ***Some authorities suggest that reading work areas can allow up to 660 lux for short periods. For materials of moderate light sensitivity, visible light levels should be kept under 600 lux and UV should be limited to no more than 75 μw / lumen. In both cases direct sunlight should be consistently avoided.***

The Use of Light

Light is typically used in libraries in two ways -- as either *ambient lighting* or as *task lighting*. It is important to understand the differences.

Ambient lighting defines the general experience of the library visitor, conveying a psychological mood within the interior space. Used correctly, ambient lighting provides the experience of not being confined within an enclosed space. Ambient lighting will change through the day and through the seasons. Many architects feel daylight provides extraordinary color and psychological benefits. Consequently, a large number of libraries are composed of extensive walls of glass to provide natural daylight essential in ambient lighting. It is appropriate to observe that an equal number of institutions are built with little or no ambient light, causing no discomfort among patrons.

Ambient lighting is often seen as a serious threat to the preservation of collections since it allows large amounts of both visible and ultraviolet light to impact collections. Naturally it is much easier to eliminate daylight than to control it, if its color and psychological benefits are discounted. Consequently, ***the ideal goal for libraries is to develop ways of using the good qualities of ambient light, while protecting collections from direct exposure.***

Such approaches include using pierced vaults and courtyards to introduce ambient light into the building. Other institutions have used fixed vertical light monitors which allow the light to enter the structure indirectly, bouncing off designed surfaces and being controlled by the configuration of the monitor.

If the decision to use daylight has been made, vertical monitors also reduce the potential of water leakage and condensation so frequently associated with horizontal lights, such as skylights.

There are several techniques discussed below that can be used to filter UV light. One that is particularly useful when ambient light is bounced off surfaces is a UV-absorbing material. A variety of white paints containing titanium dioxide, lead white, or zinc white will significantly reduce UV radiation. If this approach is selected, it is essential that future maintenance operations consistently use a UV absorbing paint.

Task lighting, in contrast, illuminates work areas, book stacks, and similar areas, without significant regard for its effect on the overall physical space. Task lighting is controlled by three factors: the spatial distribution of the lights, the intensity of the light sources, and the spectral or color distribution of the lights.

The exact level of task lighting necessary has historically been a controversial subject. European libraries typically use a lower level than those in the United States, where the levels have gradually increased through the early twentieth century. Recent evidence that much lower levels are acceptable has gained ground. This is supported by the need to reduce utility costs, since lighting can account for as much as 10% of running, cleaning, and maintenance costs at a library.

The 1981 edition of the *Illuminating Engineering Society Lighting Handbook* suggests 55 to 110 lux for inactive stacks, 220 to 550 lux for active stacks, book repair and binding areas, cataloging, circulation, and from 220 to 550 lux for reading and reference rooms. Some authorities suggest that levels of 300 lux are adequate for most tasks, as long as there are a few areas of higher intensity for difficult to read materials or for people with impaired vision. These general levels succeed in keeping the visible light in the low hundreds and are acceptable for the preservation of most library materials. ***Architects and librarians should remember that in stack areas patrons need only enough light to find books -- not to read them. Following this dictate will significantly reduce the light damage to collections.***

UV Filtration

There are a variety of ways to deal with UV radiation. It should be emphasized that ***it is essential to avoid having daylight fall on collections.*** Natural light passing through filters is far more harmful to most collections than incandescent light. Therefore, ambient daylight should be limited to public areas and excluded from collection areas. Where it is used in reading rooms, it should be filtered to reduce the cumulative effects on collections.

The ideal UV filtering material will prevent all UV down to 400 nm from passing through, but will not hinder the passage of visible light. Tru Vue® (Tru Vue, Inc., 1315 North Branch St., Chicago, IL 60622, 1-800-282-8878) produces a clear Conservation Series™ glass which blocks 99+% of the UV light. At the present time it is primarily produced as a round disk and is used as a filter for halogen lamps. Somewhat more common are a variety of plastic UV-absorbing filters. These filters are available as:

- self-supporting acrylic or polycarbonate sheets 3 to 6 mm thick which can be used in place of glass in windows if fire regulations allow or be used as an interior glazing (one example is Plexiglas® UF-3 manufactured by Rohm & Haas),

- thin foil, usually acetate, which can be cut and adhered to glass such as that produced by Solar Screen, or

- a thin foil sandwiched between glass (one example is Denglas® manufactured by Denton Vacuum).

Each type of filter has certain characteristic limitations. For example, acrylic sheets are liable to acquire an electrostatic charge, attracting dust and even pigment from pastel or charcoal sketches when used as glazing for artworks. Most acrylic sheets have a slightly yellow tint. Foils can be easily scratched or damaged. Foil sandwiched in glass has certain benefits, including increased durability and perhaps an increased lifespan.

There remains debate regarding the permanence of these various materials, although recent research suggests the plastic or acrylic carrier is likely to age and deteriorate before the UV filtering capacity is significantly reduced. Another test found only a 10% loss of filtration capability over 15 years of high intensity use. A cautious approach would be to recommend such filters be tested on a yearly basis after five years of use. Routine replacement is not warranted unless indicated by a UV test.

The high levels of UV radiation emitted by fluorescent lights can be controlled either through filtering or the use of low-UV lamps. Three types of filters are available for fluorescent fixtures:

- thin, flexible plastic sleeves which fit around the fluorescent tube,

- rigid plastic tubes which slip over the fluorescent tube and are maintained in place with end caps, and

- rigid plastic filters incorporated into the fluorescent fixture.

The first two approaches are more common since the last tends to limit the number of fixtures the designer can use. The various tubes have been criticized as trapping heat around the fluorescent tube and shortening its lifespan. Tubes and sleeves can also be troublesome to maintenance crews with the result that they will be left off during routine replacements. The tubes cost upwards of five times more than the sleeves. Both will retain their UV absorbing properties for at least 10 years, although it is appropriate to begin yearly testing after five years of use.

Fluorescent tubes emitting less than 75 μw/lumen of UV (called low-UV lamps) do not require the use of a filter, resulting in some cost savings. It is important to compare the cost of a regular fluorescent lamp with filter to the cost of a low-UV lamp to determine which is most appropriate for your institution. Less easy to calculate are the benefits of avoiding tubes and sleeves which must be changed by maintenance personnel and the decreased life span of sleeved or tubed lamps. Examples of low-UV fluorescent lamps are provided in Appendix II.

Interim Improvements

Any reduction in light levels will save money, reduce photochemical damage to the collections, and probably reduce cooling costs by reducing heat gain.

- Encourage staff and patrons to turn lights off or install automatic timers (available for both incandescent and fluorescent lamps) in closed stacks or controlled access areas such as special collections.

- Lower light levels by removing fluorescent lamps from fixtures and disconnecting the unused ballasts.

- Lower light levels by replacing standard lamps with energy efficient lamps, but be sure that UV emissions are controlled by filters. A standard incandescent lamp can be used in place of PAR lamps in track and socket lights, significantly reducing intense illumination and reducing costs. Some manufacturers have guides to replacement lamps, showing the savings resulting from various replacements (one example is *Philips Lighting Lamp Specification Guide SG-100*).

- Use light and dust covers of unbleached muslin over the front of shelves in special collection or closed stack areas. This will reduce light levels falling on the books and will also reduce particulate contamination.

- Consider blocking off windows in stack areas. Alternatively, hang UV absorbing sheets in front of these windows or apply UV absorbing film.

- Examine options for re-arranging furnishings to reduce the exposure of collections to direct sunlight.

- If blinds are in place on exterior windows encourage their consistent use. Post signs requesting that the public not tamper with the blinds, explaining sunlight damage. If blinds are not present, install them.

HEATING, VENTILATION, AND AIR CONDITIONING

Introduction

Heating, ventilation, and air conditioning (HVAC) is a frequently troublesome area of preservation. Architects often fail to understand the importance of a preservation quality HVAC, instead specifying units that are better suited to commercial construction. Librarians often don't know how to describe correctly what they need, or what the problems are with the existing system. And preservationists often fail to allow any latitude in the development of an affordable preservation quality environment. As a result, units are often designed and installed which fail to provide any constant, stable source of humidity, temperature, and air quality control.

The importance of the environment in which collections are stored should be clearly realized. For example, for approximately every 14° F rise in temperature, the deterioration rate of paper doubles. Some researchers have suggested this increase in deterioration may be found with as little as a 7° F rise in temperature.

Humidity is often associated with an increased probability of mold growth or insect infestation. Levels at 60% RH should be considered the threshold for damage -- over that level the library is likely to eventually have trouble. Since paper is hygroscopic, the humidity levels will also affect its dimensional stability. For example, a wood board one foot in length can vary up to one inch in length between 10% and 90% RH. Overly high RH levels can distort paper, while low levels can make paper brittle. High relative humidity levels can also accelerate deterioration promoted by acids in the paper, a process known as acid hydrolysis.

The quality of the air in the library will also affect preservation. Particulates are often abrasive and may permanently soil paper. Organic particulates, such as "dusts," are also perfect hosts for mold. Particulates in the library will also increase user discomfort and increase maintenance costs. In the Southeast the annual average airborne dust concentrations ranges from a high of about 90 $\mu g/m^3$ in the Kentucky area to a low of about 48 $\mu g/m^3$ in New Orleans.

Gaseous contaminants, such as nitrogen dioxide and sulfur dioxide, can attack paper by conversion to acids. Ozone is a powerful oxidant, breaking apart every carbon double bond, and severely damaging all organic material. Surprising sources of ozone occur within every library building -- most notably in photocopiers and laser printers. The effect of formaldehyde on collections has been previously discussed in the section **The Library Interior**.

The goal of any building program or renovations involving the HVAC system should be to provide equipment that will help, not hinder, the preservation of the library materials. This means maintaining appropriate humidity and temperature levels, providing clean, filtered air, and reducing the levels of pollutants in the air.

The degree of protection provided will be somewhat dependent on the funds available to the library. The protection of the collections must also be tempered against making the library user friendly. Few patrons will want to wait for their book or microfilm to be removed from the freezer and allowed to warm to room temperature, and few people will want to use a library maintained at an even 60° F year round. Humidity levels of 30% may be good for paper and film, but they may also contribute to upper-respiratory infections among staff and patrons.

All of this should not make the creation of a preservation environment sound impossible. With some work and the cooperation of your architect, it is possible and will make the library a healthier and friendlier place for collections, staff and patrons.

The Ideal

When a preservation quality environment is researched the first thing librarians notice is the lack of agreement between different sources. Some will specify the correct temperature is 68° F ± 2°, others will suggest a range of 68° to 72°, and so on. Similar problems are encountered when relative humidity, particulate, or gaseous pollution levels are examined.

Table 1 provides some *general recommendations* regarding environmental levels for different types of common library materials. It represents a compilation of a variety of sources, each of which should be consulted for more specific information. Typically, ***humidity is more important than temperature and should be controlled first. Further, fluctuations may be more damaging than consistent levels, whatever they may be.*** In addition, these recommendations would be made even more strict for especially valuable collections or for what is often called a "conservation environment" typical of archives and museums. For example, the National Information Standards Organization (NISO) is working on an environmental standard for books and paper.

To the temperature and humidity levels of Table 1 should also be added acceptable fluctuations. For example, one researcher has suggested that the relative humidity can vary ± 3% diurnally and ± 6% seasonally, while temperature can vary ± 5° F.

Ventilation is especially important for libraries since it ensures the health and well-being of staff and patrons (the primary concern of the American Society of Heating, Refrigerating, and Air Conditioning Engineers [ASHRAE] Standard 62-1989, *Ventilation for Acceptable Indoor Air Quality* and ASHRAE IAQ 89, "The Human Equation: Health and Comfort). Proper ventilation also helps to minimize the potential for mold outbreaks by providing adequate passage of the air through high efficiency filters and maintaining air movement. ***Pockets of stagnant air in a library are a sure invitation for mold problems and should be carefully avoided by the mechanical engineer.***

In the absence of adequate filtration,

Table 1.
Preservation Environment

RELATIVE HUMIDITY
Paper: 40% - 50%
Film: 30% - 40%
Leather: 50% - 55%
Vellum: 40% - 45%

TEMPERATURE
Paper: 65° - 70° F
Film: 55° - 65° F
Leather: little research
Vellum: little research

PARTICULATE FILTRATION
Minimum level for all materials is a filter to remove at least 50% of all particles down to 0.5 microns (95% ASHRAE Dust Spot Efficiency is preferred).

MAXIMUM LEVELS OF GASEOUS POLLUTION
Sulfur Dioxide: 1 to 10 $\mu g/m^3$ or 0.38 to 3.8 ppb
Oxides of Nitrogen: 5 to 10 $\mu g/m^3$ or 2.5 to 5.0 ppb
Ozone: 2 to 25 $\mu g/m^3$ or 1.0 to 12.8 ppb

Adapted from William P. Lull and Paul N. Banks, Conservation Environment Guidelines for Libraries and Archives; Southeastern Library Network, Environmental Specifications for the Storage of Library and Archival Material; Garry Thomson, The Museum Environment. A conservation environment may be even more strict.

duct work can become clogged. These debris are not only potentially damaging to collections, but may also present unacceptable health risks to staff and patrons. Return-air ducts are often worse than supply ducts. Ducts can be visually inspected, using inspection ports, or through the use of a borescope inserted into drilled holes. Cleaning can be accomplished by commercial firms using rotary brushes and vacuuming. Typically biocide treatments should only be undertaken in those areas of public use.

The concerns associated with formaldehyde and similar indoor construction and building material pollutants has been discussed in the section on **The Library Interior**. Beyond those pollutants, the library should ensure that it closely regulates the ability of staff and patrons to smoke. Not only is this practice a fire hazard and linked to health risks, but it also serves to introduce a variety of damaging particles into the library airstream, most of which typical HVAC systems cannot readily remove.

Recently companies have developed various techniques to monitor environmental tobacco smoke. Tests such as that produced by Assay Technology in Palo Alto, California respond to the alkaloids in tobacco smoke and provide equivalence to the number of cigarettes smoked. This test can be useful to determine if staff smoking is affecting collections.

What all this means to the public library is sometimes difficult to understand, but it may be interpreted as requiring:

- maintaining a relative humidity between 45% and 55% throughout the year, allowing seasonal fluctuations between the two extremes, but minimizing daily fluctuations,

- maintaining temperature between 65° and 75° F throughout the year, allowing seasonal fluctuations between the two extremes, but minimizing daily fluctuations,

- designing filtration to remove at least 50% of particulates using the ASHRAE Dust Spot Efficiency Test,

- designing gaseous filtration to maintain preservation standards throughout the facility, or using area filtration as necessary, and

- providing adequate ventilation to avoid stagnant air pockets, "dead" zones at the ends of ranges and corners of stacks, and similar problems that are conducive to the growth of mold and mildew.

Unfortunately, HVAC or mechanical engineers are most familiar with the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) guide to human comfort. Figure 6 demonstrates that the zone of human comfort is often very different.

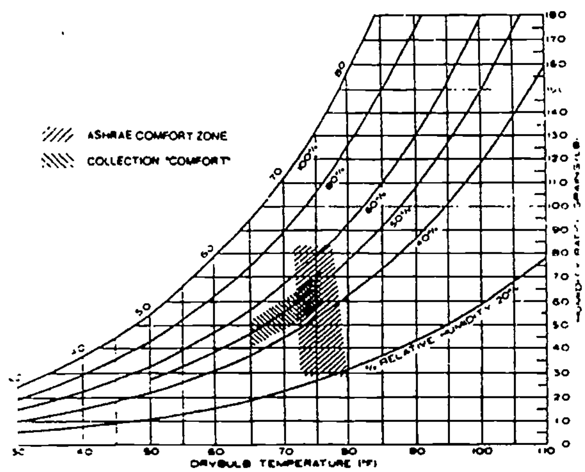

Figure 6. Zone of human comfort compared to the "zone of collection comfort."

Consequently, when architects and mechanical engineers discuss "comfort" and "design" levels, they are almost always expressing concerns that fail to include the needs of collections.

Major Components of an HVAC System

Without going into detail, a typical large HVAC system may contain a chiller, a cooling tower, a boiler, and one or more air handlers. The chiller provides the cooling, circulating cold water (or other liquid, such as ammonia) to the various air handler coils. Air passing over these coils is cooled, effectively cooling the library. The cooling tower is used to dissipate the heat collected by the refrigerants as they are used in the coils. The boiler produces either steam or hot water. Both can be used for heating purposes (used in the coils the same way as the chilled water) or for dehumidification (discussed below). The air handlers consist of a fan, filtration, and the coil. They are used to distribute the clean cooled or heated air.

Smaller libraries may use direct refrigeration units (also called DX or direct expansion units). These units may contain a packaged cooling system (including the coils, filter, and fan) and a condenser mounted outside the building (serving the purpose of a cooling tower in a larger system).

The decision of which to employ is usually determined by the size of the institution. Both can satisfy the preservation needs of a library, *if properly designed.* Essential elements include:

- The use of a *constant air volume* system which constantly circulates air at full volume. Often the architect or mechanical engineer will use a variable air volume (VAV) system rather than a constant air volume system. The VAV system delivers cooled or heated air in proportion to the heating or cooling needed in a specific zone. While this approach saves energy costs, it does so by placing the maintenance of a stable humidity at risk. Such systems also cannot properly filter the air or maintain sufficient air flow to help prevent stagnant air pockets. Within the past few years some buildings have been designed using a modification of VAV, called terminal regulated air volume (or TRAV). Libraries should also avoid the use of this system, for very similar reasons.

- The limitation of outside air makeup to that required by the local codes and ASHRAE Standard 62-1989. Libraries should not use air economizers, which introduce large amounts of outside air for "free" cooling and heating. These systems, which are primarily responsive to temperature needs, make it virtually impossible to maintain stable relative humidities.

- Design based on humidity, rather than temperature, control. It is preferable for temperature to fluctuate, rather than RH, and all controls should be designed with this specification in mind.

- The use of electronic, rather than less sensitive, and reliable, pneumatic, controls in the occupied spaces, *not* in the return ductwork. There are two types of electrical-based relative humidity sensors -- bulk polymer and thin film capacitance. Both are very accurate (available in 3% and 5% accuracy models) and have long-term stability not obtainable with conventional pneumatic controls.

- The use of reheat coils for dehumidification of cooling air and clean steam humidification. Reheat coils allow the air to be super-cooled by the coils, driving off excess moisture, and then to be reheated to the appropriate level. Dehumidification using desiccant drums is not only a costly alternative, but it is more difficult to maintain and may release a fine dust or powder into the air stream. Clean steam dehumidification is preferred over all other humidification techniques.

- The use of prefilters (typically 70% ASHRAE Weight Arrestance) and final high efficiency filters (at least 50% ASHRAE Dust Spot Efficiency), with each bank monitored by a manometer. This gauge indicates when the prefilters and final filters are "dirty" and need to be replaced based on the pressure drop as air moves through the clogged filters. The use of electronic air cleaners should be avoided since they release ozone into the air.

- Constant operation of the HVAC system to ensure adequate environmental controls and eliminate sharp spikes and excess fluctuations of temperature and relative humidity.

These essential design features will help ensure that the library system is capable of achieving and maintaining a preservation quality environment.

Libraries should also be very cautious in the use of ducts with internal insulation. The air flow through these ducts can entrap the fiberglass particles, distributing them throughout the building. If in-duct insulation must be used, this internal insulation should be coated with an inert substance for isolation. When duct work is not insulated, the library should require the use of duct silencers to prevent the transmission of equipment noise.

Recently two additional features have become available to libraries -- energy management systems (EMS) and direct digital controls (DDC). A computerized energy management system has the potential of reducing energy costs by 15% to 40% and can be productive in buildings as small as 10,000 to 50,000 square feet. The payback period in energy savings can be as short as a year. Computerized energy management systems control energy use through time programming, event programming, electrical load cycling and shedding, electrical load peak demand reduction, chiller optimization, and boiler plant optimization. In addition to these cost reducing benefits, EMS can provide improved labor efficiency, reduced maintenance costs, and extended equipment life. The system can also help monitor crucial areas of the library.

Additional energy savings are often possible by combining EMS with direct digital controls (DDC). Instead of traditional control components, such as thermostats and receiver controllers, a DDC system uses microprocessors that perform the control logic functions. DDC can be used to provide better management of the library environment, reduce the costs of both energy and labor, improve the quality of the environment, reduce or eliminate calibration requirements, improve control strategies, and provide 24-hour monitoring with computer printout capabilities. From a central processing unit the library staff can monitor and control temperature and humidity, reset areas, obtain a log of all conditions for reference or diagnostics, and much more. Further, additional equipment can be tied into the DDC system, such as security, fire detection and suppression, and evening lighting or lawn sprinklers.

Humidity Control

An article in *Heating/Piping/Air*

Conditioning suggested that even HVAC systems in commercial office buildings should be designed to maintain humidity levels between 40 and 60%[1]. While this recommendation may result in some additional energy costs, these can be minimized by special design approaches.

Often the most complex design feature for libraries is to provide adequate humidification and dehumidification. The goal should be to design a system that not only functions properly, but which also functions economically. While there is a discussion of recent energy conservation research below, it should be noted that it typically requires less energy to maintain a facility at 50% RH at a high temperature than at a low temperature. To maintain a space at a low temperature and humidity will require more latent and sensible cooling than maintaining the space at a higher temperature and the same relative humidity.

Consequently, it is essential that the mechanical engineer explore a variety of humidity control systems to determine which is most likely to provide the desired control with the lowest initial and operating cost.

There seems to be general agreement that the most efficient and economical humidification for this region is provided by small zone steam injection humidifiers. Dehumidification is best obtained through a reheat option making use of carefully designed extended surface or finned coils.

Energy Conservation

One of the most exhaustive studies on energy conservation and a conservation environment is that conducted by the Getty Conservation Institute [2]. This document, while intended for museums and other institutions requiring a conservation environment, should also be reviewed by mechanical engineers working for libraries.

Essential to energy conservation is the design of the building envelope (discussed in detail in a previous section). A major issue is the consistent use of thermal and vapor barriers. Library architects should ensure adequate insulation, use double or triple glazing, avoid infiltration, prevent moisture migration, and avoid the use of skylights and windows. Involved in this design stage is the need to ensure that the HVAC systems are developed to minimize energy consumption while ensuring the design set points are achieved.

The Getty study also examined a variety of set points for temperature and humidity, finding that a set point of 70° F and 50% RH resulted in the minimum energy consumption of all conservation/preservation environments studied. Further, there is only a very slight reduction in energy consumption as humidity tolerance of the system was allowed to increase (i.e., 50±2%, 50±5%, 50±7%). There was a slightly greater savings by allowing seasonal fluctuations, although this saving was also relatively minor. The study found a 1% reduction in cooling cost by increasing the temperature from 70° to 75° F in the summer and a 6% reduction in heating/humidification energy consumption by decreasing the temperature from 70° to 65° F in the winter (maintaining the relative humidity at 50% throughout).

Of some use to planners is the finding that in the Southeast the energy consumption of cooling is only slightly greater than that of heating and humidification, while the consumption of fans/pumps and lighting are about equal and only a third of either heating or cooling.

Additional savings can be achieved through the use of appropriate windows with low k-values (k-value indicates how much thermal energy is transferred outside through

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[1] Hartman, Thomas "Humidity Control," *Heating / Piping / Air Conditioning* (September 1990): 111-114.

[2] Ayres, J. Marx, J. Carlos Haiad, and Henry Lau. *Energy Conservation and Climate Control in Museums*. Marina del Rey, California: Getty Conservation Institute, 1988.

window and the smaller the k-value, the lower the heat loss). While ordinary single glazing windows have a k-value of 4.5 to 7, double pane glazing has a k-value of 3.0 to 3.4, and double pane special insulation glazing with a metal oxide layer and rare gas filling has a k-value of 1.6 to 1.9.

In retrofitting HVAC systems it is appropriate to investigate the installation of new high efficiency chillers and natural gas-fired pulse-combustion steam boilers. The Getty study also found that heat recovery chillers can provide significant savings in mild climates, where much of the energy used for heating and humidification can be recovered using double bundle heat recovery chillers. Unfortunately, the Southeast is not a typical mild climate area and this technique is not likely to be effective.

Some engineers suggest investigating the use of heat wheels and heat exchangers to optimize energy recovery and reduce the effect of outside air loads on the HVAC systems. They note that heat wheels, which reduce the sensible and latent heat of outside air are especially useful in hot, humid areas of the Southeast (sensible heat is the kind of heat that increases the temperature of the air; latent heat is the kind that is present in increased moisture in the air).

Interim Improvements

As previously discussed, the first step in all building renovations should be sealing the structure -- using caulk and weatherstripping to make the library weather-tight. This step alone will improve the physical condition of the building, reduce air infiltration, reduce pest access, reduce the heating/cooling load, reduce air pollution, and reduce the particulates in the building. Making the building watertight (also previously discussed) will reduce the sources of water vapor within the structure and may significantly reduce the relative humidity levels.

Better cleaning, using damp mops and high efficiency vacuums, will reduce the particulates in the library. Hard floors should be damp mopped as frequently as possible and require waxing to prevent them from holding dust. If carpets are used, they must be vacuumed at least weekly.

The library should segregate pollution-producing activities, such as smoking, copiers, laser printers, from the collections. Ideally a room for photocopiers will be provided, with each copier vented outside.

Only preservation quality materials should be used. Avoid materials which will off-gas and cause additional damage. Emphasize the use of pH neutral, alkaline buffered storage containers.

It may be possible to install a central drain-through evaporative pad humidifier on forced air systems. While not as effective or reliable as the in duct steam system, it is acceptable. Such systems, while requiring some maintenance, can usually be installed relatively inexpensively . Dehumidification can also be obtained as "add-ons" to the existing system.

Supplemental filtration, including gaseous filtration, can be obtain by "add-ons" (such units are produced by a variety of companies, including Purafil™, 1/800/222-6367 and Farr Company, 1/800/777-5260). Where only a single room, such as special collections, requires the additional protection, the cost for room filtration can be as low as $1000. It may be possible to install higher efficiency filters, with only minor modifications to existing fans.

Better filtration may be achieved through the replacement of standard 1 inch fiberglass filters with a 1 inch extended surface or pleated filter. These filters increase the surface area of the filter through the use of pleats, providing better filtering capability. While a 1 inch fiber glass filter may have an average ASHRAE Weight Arrestance of 70%, a pleated filter may achieve a ASHRAE Dust Spot Efficiency of 30%. Another option for improved particulate filtration may be the electrostatic air cleaning filters, which are electronic and do not therefore generate ozone.

Libraries in urban areas with heavy smog should investigate the use of a combination fiberglass/potassium permanganate filter (such as those manufactured by Cameron-Yakima, Inc., P.O. Box 1554, Yakima, WA 98907, 509/452-6605). This would provide some control over the gaseous pollutants.

As in all cases involving modifications to the HVAC system, the library's architect and/or mechanical engineer should be consulted for professional advice specific to the institution and its existing equipment.

Alternative Designs

While the design features outlined here are essential for the preservation of paper and other library materials it is regrettable public libraries often cannot afford all the measures recommended. In such a situation, ***the librarian should maximize the protection given to the collections within the limitations of the design and operating budget.***

One approach is to design the library to minimize the daily and seasonal fluctuations of temperature and humidity. This "design smart" idea would incorporate a variety of features discussed in the earlier section on **The Building Envelope**, such as maximizing the thermal efficiency, building small with heavyweight materials, minimizing wasted spaces, ensuring an airtight envelope, and so forth. This approach will allow the size of HVAC system to be reduced and result in a cost savings. In addition, this approach will minimize the fluctuations resulting if the HVAC system must be shut down at night.

Another approach is to recognize that collections need a more stable environment than staff offices, open reading rooms, meeting facilities, and similar areas of the building. By reducing the size of the specially designed HVAC system to cover only the stacks, the costs will be appreciably reduced. Of course, this also requires the stacks be separated from the remainder of the library, which may be difficult with some designs and impossible for smaller, branch libraries.

The library may determine that damage to some parts of the collection resulting from inadequate environmental control is acceptable, while damage to another part of the collection is unacceptable. The HVAC system would be designed with this division in mind, providing minimal controls for most areas and maximal controls for one or more small portions of the library. An example of this approach is having special collections, such as the local history room and microfilms, receive special HVAC design treatment while the remainder of the facility receives "routine" design work (equated with typical commercial installations making use of VAV and air economizer systems).

There are a variety of self-contained units that can be cost-effectively installed to provide a preservation quality environment for a single room. One such example is the Liebert® mini-MATE Plus, which is capable of handling re-heat dehumidification, steam humidification, and high efficiency particulate filtration. Units are sized from 2 to 5 tons for air, water, glycol, and chilled water applications.

Before any such "compromises" are made the library must be sure that both they and the architect clearly understand the needs of a preservation environment and the consequences of the compromises being suggested. It is much less expensive to design a system which "works" during this phase than to adjust and tinker with a system for years afterwards, all the while suffering with molds and inadequate operation.

FIRE PROTECTION DESIGN

Introduction

In the decade of the 1980s, 346 fires were reported from libraries and museums. Of these, the leading cause was arson or "suspicious causes." The second most common cause was the electrical distribution system. Taken together these account for over half of the reported fires and the majority of the property damage. In 1990 there were 8,500 fires in educational facilities, with property loss valued at $136 million.

A fire is reported every 16 seconds in the United States and every 100 minutes there is one death attributable to fire. The losses to fire amount to $250 every second.

Although no institution can be made totally safe from fire, the surest protection involves the integration of seven features in the planning:

- use of fire-resistent or fire-proof construction,
- compartmentalization of the library and installation of secure fire walls and fire doors,
- elimination of vertical draft conditions,
- minimum use of combustible materials in interior finishings and furnishings,
- installation of protective devices, such as automatic fire doors, cutoff air circulation ducts, and appropriate portable fire extinguishers.
- installation of a good fire detection and signalling system, and
- installation of an automatic sprinkler system for the entire facility.

This section provides a basic introduction to the design of a fire safe library. For additional information, the Southeastern Library Network (SOLINET) publication, *Can You Stand the Heat? A Fire Safety Primer for Libraries, Archives, and Museums* should be consulted.

The library's architect will certainly be familiar with both the fire codes of the local jurisdiction having authority, as well as the extensive recommendations and standards of the National Fire Protection Association. Consequently, it is not unreasonable to leave the exact details of compliance up to the architect. ***The library should educate the architect on the importance of designing a building with the fire threat in mind, emphasizing the need to not simply comply with minimum code provisions, but to seek ways of expanding the level of fire protection.***

Building for Fire Safety

Fire resistant construction is designed to allow the burnout of contents without structural failure. While such design does not assure life safety, it does prevent structural failure of the building affecting the protective enclosure of exits. The goal is to assist in the evacuation of the building during fire conditions. In Type I or fire resistive construction all of the structural members are noncombustible and are fire-protected to strict requirements. Type II or noncombustible construction requires the use of noncombustible or limited combustible structural materials. *All libraries should conform to one or the other classification.*

The goal of compartmentalizing is to confine a fire to the room or suite of rooms where it originated or to retard its progress from one space to the next. This can be accomplished by segregating spaces with higher levels of fire hazard from those with lower levels. The segregation is achieved by using a variety of design features, such as fire walls, fire doors, self-closing devices, and so forth. Compartmentalizing will typically limit the size of the fire and the amount of damage.

The protection of vertical openings is equally significant for life safety and exit design. Vertical openings act as chimneys, with smoke, hot gases, and flames spreading quickly upward. Since the flames and smoke tend to spread upward, the most serious situations occur when the fire originates below occupants, for example in basements. Fire fighting efficiency also decreases rapidly as the fire spreads vertically, with multistory fires difficult to control and virtually impossible to extinguish by manual techniques. ***Libraries should avoid construction techniques such as open stairwells, curtain wall construction, poke-through assemblies, and vertical ductwork. Shafts for power, communication, computer and similar cables that must travel vertically in multifloor buildings should be firestopped at each floor.***

Libraries renovating an older structure should pay particular attention to the elevators. Most elevator companies can upgrade an older system to incorporate "elevator capture," or the automatic recall of elevators to the main floor in the event of a fire. Such systems use smoke sensing devices on each floor to prevent the elevator from stopping without the use of an over-ride key.

Few fires originate with interior finishes, although these finishes can become involved and can contribute extensively to the spread of the fire. Studies also have shown that interior finishes significantly contribute to the condition called "flashover." ***Ideally all interior finishes in the library will be noncombustible or will have an A classification*** (National Fire Protection Association 101, *Life Safety Code*) and interior floor finishes will be of a Class I material (National Fire Protection Association 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*). Interior finishes must also be carefully applied, according to the manufacturer's instructions.

Furnishings and decorations play an increasingly important role in the loss of life by fire. Many materials do not so much burn as they emit vast quantities of dense smoke and deadly gases. Yet, these materials are difficult to regulate since they are not actually built into the structure. ***The librarian and architect should both recognize the importance of fire resistant furnishings in the library. Furniture such as desks, chairs, and tables should be either non-combustible or of fire-retardant treated wood. All upholstery and plastics should be self-extinguishing. Draperies and curtains should be flame proofed. Carpets (if they must be used in the library) should be of commercial grade low-flame spread rating.***

There are a variety of protective devices the architect can suggest (or which may be required by local fire codes). These include such design features as outside vents with fusible links with curtain boards to speed their opening. While there is still some controversy regarding the usefulness of vents in sprinklered buildings, their use should be investigated by the architect. Ductwork for the HVAC system that penetrates fire walls or extends vertically should be firestopped with the use of automatic fire dampers.

The National Fire Protection Association also recognizes that smoke control can be achieved through either a passive approach, using compartmentalization, fan shut-down, and the use of fire and smoke dampers or an active approach in which the HVAC system is designed to create differential pressures to prevent smoke migration from the fire area and to exhaust the smoke to the outside.

The two approaches should be carefully

evaluated, and the decision should be made on the basis of the approach most likely to promote life safety and minimize damage to the library materials. It may be that the library design will be such that there is no need for smoke control. One excellent discussion of this issue is Michael Dillon's "The Other Risk in Smoke Control Design" in the July 1991 issue of the *ASHRAE Journal*.

If the library is incorporating a parking garage, fire protection should also be designed into its construction. Some fire experts are reluctant to recommend a sprinkler system in garages, arguing that while most car fires will burn out without spreading, the water from a sprinkler system may carry pools of burning gasoline from car to car, making the fire worse. Regardless, all experts agree garages should have carefully designed detection and warning systems coupled with good ventilation.

Fire Extinguishers

Most fires start out small and could be easily extinguished or controlled if the proper amount of the correct extinguishing agent were applied. Portable fire extinguishers are a first line of defence against these small fires. But if they are to be effective they must:

- be properly located and in good working order, and
- be the proper type for the fire.

While it is difficult to recommend one type of extinguisher for all libraries, most will be satisfactorily served by a stored pressure multipurpose dry-chemical extinguisher. Such extinguishers can be used on Class A:B:C fires including ordinary combustibles such as paper and wood, flammable liquids such as gasoline and greases, and fires in live electrical equipment. The only serious drawback to this type of extinguisher is the chemical used is corrosive and hardens as it cools. Consequently, clean up can be difficult. In spite of this, the dry chemical extinguishers are simple to use, effective, and relatively inexpensive.

The National Fire Protection Association Extinguisher Standard (NFPA 10, *Standard for Portable Fire Extinguishers*) explains the distribution of extinguishers in considerable detail and will be very familiar to the library's architect. In brief, if the facility uses a 10A:60B:C extinguisher (such as the Ansul® Sentry™ Model SY-1014) the maximum travel distance to the extinguisher should be no more than 50 feet. It is always better to have too many fire extinguishers, especially considering their very low initial and maintenance costs.

A novice operator using the cited 10A:60B:C extinguisher will be able to extinguish a fire covering 60 square feet (the equivalent of an area measuring about 7½ feet square). An experienced operator will be able to extinguish a fire covering about 150 square feet. Weighing slightly over 17 pounds the unit can be used by most adults without difficulty.

The cited extinguisher should be mounted no higher than 5 feet from the floor to the top of the extinguisher. No extinguishers should be mounted closer than 4 inches off the floor. This means that extinguishers used to prop open doors or which are placed in corners do not satisfy code requirements. The extinguisher should not be obstructed and should be in plain sight.

While it may be attractive to hide the extinguisher in cabinets which "blend-in" with the library decor, this should never be allowed to detract from the ultimate usefulness of the extinguisher. In particular, locking cabinets where the potential user must either break a panel or engage an elaborate unlocking mechanism should be avoided if at all possible. Intended to be used in high vandalism areas where it is important that the opening of a cabinet and discharge of an extinguisher can be easily detected by visual inspections, these locking cabinets are usually not necessary in a library. There are a variety of non-locking cabinets made which provide high visibility protection to the extinguishers (Figure 7). Recessed or semirecessed cabinets are better

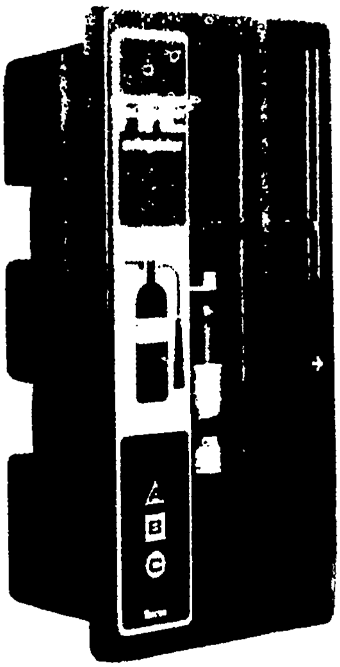

Figure 7. Semi-recessed fire extinguisher cabinet.

maintenance choices than surface mounted cabinets although the latter are easier to use in retrofits. The various extinguisher manufacturers also produce brackets specifically designed to be used where extinguishers may be accidently dislodged, as an alternative to cabinets. One manufacturer, STI, is also producing a fire extinguisher alarm, which sounds when the extinguisher is removed from its holder. The alarm is battery operated and does not interfere with the normal use of the equipment. This device might be appropriate for areas with a moderate risk of vandalism.

The library may also wish to install a limited number of Halon 1211 extinguishers. Halon 1211 (bromochloroidifluoromethane) is a "clean" agent, leaving no residue, being virtually noncorrosive and nonabrasive. It is well suited for computers and valuable collections. This compound, as with other fluorocarbons, is damaging to the environment and its use is being restricted. Regardless, it is not inappropriate for libraries to install these extinguishers to protect especially valuable materials or collections. They should not, however, be used routinely throughout the library (both because of cost and environmental consequences). The library should realize that the production of various Halon compounds is being reduced, although new replacements which are much less damaging to the environment are already being developed.

An appropriate Halon extinguisher is the Ansul® Sentry™ Model SY-1441, rated at 2A:40B:C and weighing just under 22 pounds. Smaller Halon extinguishers are often not rated for use of combustible material (Class A) fires.

Libraries should avoid the use of smaller, inexpensive plastic extinguishers. These models may, or may not, be reliable. Few can be refilled after use. They are designed for the homeowner who is unwilling or unable to purchase a more reliable model and to undertake the maintenance associated with fire extinguishers. Because of the risk, and the potential loss, libraries should use only the best fire protection equipment.

Fire Hoses

Many libraries, most notably those in multistory structures, have installed standpipe and hose systems for building occupants to use until the fire department arrives. Since these systems are intended for use by untrained individuals they are equipped with 1½ inch hoses. Unless required by the local jurisdiction having authority, there is little point in installing this equipment. The novice use of a fire hose, even one that is putting out "only" 100 gallons of water a minute at a pressure of 90 psi, can often do more damage than good. It can also prove dangerous to use in unskilled hands. The library would be better served by devoting the funding necessary for this equipment into a sprinkler system (discussed below).

Fire Detection Equipment

There are essentially three types of fire detectors:

- flame detector, which

responds to the flame stage of a fire,

- heat detector, which responds to the heat generated at the flame stage of a fire, and

- smoke detector, which responds to the particles of combustion early in the fire.

The flame and heat detectors have rather specialized uses and should not be the primary detection device in a library. The flame detector is very fast, sensing flames within millisecond, but its use is limited to circumstances in which the fire is not likely to smolder or produce combustion products prior to the actual fire. It would be appropriate for spaces where flammable liquids are stored, for example the garage where the bookmobile is parked, especially if there is an indoor gas pump. The heat detector sets off an alarm when the heat reaches a specific, preset level. While they are the least expensive detectors available, they are also the least sensitive and typically provide the alarm after the fire has reached major proportions. They are best suited to duct work where conventional detectors are likely to create false alarms.

More appropriate for a library setting are smoke detectors, which may be either ionization detectors or photoelectric detectors. Generally, the ionization detector will provide a faster response to open flaming fires that produce a large quantity of small smoke particles. Photoelectric detectors provide somewhat better response to smoldering fires. The ideal solution is to use a detector that combines the two types in one unit. But *regardless of the specific type selected, smoke detectors are the preferred detection device in the library settir¬.*

All detection systems will be incorporated into a signalling system. While there are five basic types (local, auxiliary, remote, proprietary, and central station), the library planner will typically need to be concerned with only general parameters or requirements.

A local alarm system provides notice of the fire condition only to the building occupants. Its primary function is life safety, alerting the occupants they should evacuate the building. Presumably, the staff will also call the fire department. This system is effective only if the building is occupied, otherwise it is likely that the alarm will go unnoticed.

The planner should therefore ensure that the signalling system will alert the fire department, either automatically or through some intermediate party such as a monitoring security company. The system should also be attached to an annunciator panel, which will allow the fire department to quickly identify where the alarm initiated.

Automatic Sprinkler Systems

The best possible fire control system for libraries is the automatic sprinkler. Sprinklers provide much faster response to fire conditions than even a local fire department, and a sprinkler system is likely to control or extinguish a fire using less water than a typical fire department response once the fire has gained momentum. Sprinklers can save both lives and reduce property losses in the event of a fire. In fact, one study suggests a sprinkler system can reduce property losses by nearly $8000 in the event of a library fire. In addition, sprinkler systems installed in commercial property can pay for themselves in as little as five years through reduced insurance premiums.

There are still a few who fear the water damage associated with the discharge of sprinklers. Yet, a typical sprinkler head releases between 15 and 56 gallons of water a minute, compared to the 250 to 350 gallons of water a minute released by a single 2½ inch fire department hose. And 70% of all fires are controlled by four or fewer sprinklers -- releasing less than 170 gallons of water a minute. It is clear that sprinklers will cause less water damage than a fire department response.

Some also believe that sprinklers will "accidently" discharge, without warning, and without any fire condition. The odds of a sprinkler activating because of a defect is less than one in one million. The testing procedures used on sprinkler heads far exceed the normal abuse they receive in a library. When defective, sprinklers tend to leak or drip, not discharge.

There are numerous good reasons to include a sprinkler system in the library design and construction. There are no good reasons to leave out a sprinkler system.

There are two basic types of sprinkler systems suitable for libraries:

- wet pipe systems, and
- preaction systems.

In a wet pipe system there is a piping network containing water at all times. When a sprinkler head is activated, water is immediately released on the fire. This system is the more simple, and it quickly releases water on the fire source.

A preaction system is more complex, and hence more costly, although it does provide the library with an additional degree of protection. In this system all of the pipes are pressurized with air or nitrogen. The preaction valve is activated by an independent fire detection system such as the library's smoke detectors. The opened preaction valve allows the piping to fill with water, but this water is not released until the fire actually fuses one or more of the sprinkler heads. This system uses dry pipes until there is a possible fire threat, at which time the air or nitrogen is released and the pipes fill with water. The delay in actual water discharge allows the staff or fire department time to locate the fire source and possibly extinguish it. The preaction system also avoids the release of water should a sprinkler head be dislodged through vandalism since no other detection devices were activated.

There are also a variety of sprinkler head designs. The typical sprinkler head (Figure 8) is either closed, or when the heat

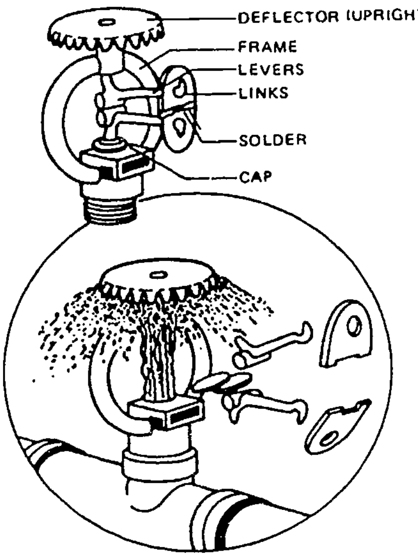

Figure 8. Typical sprinkler head in closed and open positions (adapted from Wayne G. Carson and Richard L. Klinker, *Fire Protection Systems*, 1986, National Fire Protection Assoc.)

from a fire fuses the head it opens, releasing water. Recently there have been several cycling sprinkler heads introduced on the market. One is the Flow Control™ by Central Sprinkler Corporation. This device is manufactured to open under fire conditions, releasing water, and then to close when the temperature is reduced below a certain point. Should the fire flare back up, the sprinkler head will again open, applying more water.

In theory this is a tremendous advantage for libraries, since it limits the amount of water placed on the fire and the collections. Some fire experts have expressed concerns that this cycling effect may actually increase the risk, allowing the fire to flare up repeatedly, each time involving new materials and emitting more smoke. At the present time this is an unsettled issue and librarians should discuss this concern with their architect and fire engineer.

Total Flooding Systems

Some institutions inquire about the possible use of a total flooding agent such as Halon 1301 (bromotrifluoromethane). These systems require that collections be located in relatively small, very tightly sealed rooms. Under fire conditions, the agent is released, flooding the room. The fire is extinguished, or controlled, through its exposure to an adequate concentration of the extinguishing agent for a sufficient period of time.

As previously discussed, Halon is an environmental threat and its use is being increasingly regulated. The design and construction of a suitable room is complex, and the system is relatively expensive. It is also essential that personnel in the room leave immediately during an alarm condition.

The best evaluation of total flooding Halon systems is that there are appropriate uses. Collections of very high intrinsic or monetary value might best be protected using Halon. Master microfilm negatives could be well protected with this system. But for most routine library materials Halon is probably not warranted. The careful design and installation of a traditional fire detection and suppression system should be adequate.

BUILDING FOR PEST CONTROL

The Basics of Library Integrated Pest Management

The typical library tends to handle its pest control problems in one of three ways: the problem will be ignored until it reaches crisis proportions, a staff member will be appointed "to handle the situation," or the problem will be turned over to a commercial pest control company and toxic pesticides will be applied. Each of these options exhibits some basic misunderstandings of how pests can be effectively and safely controlled. The "do nothing" approach will surely lead to the damage or destruction of the collection. Pests do not "take care of themselves"; they continue to spread and eat. Turning the situation over to a staff member, usually overworked maintenance personnel with little or no experience in pest control, can result in a variety of problems. Either little or nothing will be done, or a variety of "over the counter" pesticides will be used indiscriminately. Use of a commercial pest control firm may, or may not, get rid of the offending pests, but usually the library will have no idea what pesticides were used; how those pesticides will affect patrons, staff, and collections; where the pesticides were used; or how long the treatment will last.

There is a fourth option -- *integrated pest management*.

Integrated pest management (IPM) is not new to the pest control industry, but its application to structural pests (and particularly to library settings) is not yet as common as it deserves to be. An IPM approach to pest control minimizes (and in some instances may actually eliminate) the use of chemicals, in their place emphasizing cultural, mechanical, and biological controls.

There are four major components to a successful IPM program:

- monitoring pest populations,
- assessing the acceptable pest population and associated damage,
- identifying control methods, and
- evaluating the success of the process.

IPM programs, unlike most conventional treatments, are not static, but should be designed for constant adjustment and refinement. The primary advantages are that stable, long-term control of most pest populations is possible and the use of chemicals is minimized. This last feature is often the first to be noticed -- where previously an institution would have a pest control firm come in monthly and spray "something," with IPM the treatments, if necessary at all, will perhaps be only every three to six months.

There is a down side to IPM. This approach requires a greater commitment from the library. No longer are pest problems simply turned over to a pest control firm. The library must be an active participant in the process.

The first step in an active IPM program is monitoring, which takes a variety of forms. One of the more significant is the use of sticky traps, checked at least weekly to determine the presence of pests, their identity, their location, their life stage, and their numbers. The number of traps used and their placement are essential to effective monitoring, but no more so than the dedication to consistently examine the traps for signs of pest activity. In addition

Table 2.
Common Pests of Books

Bookbindings	Deathwatch beetle, *Xestobium rufovillosum* anobiid bettles (many varieties) Booklice, *Liposcelis* spp. (feed on molds)
Books and Paper	termites (all varieties) Drugstore beetle, *Stegobium paniceum* Silverfish, *Ctenolepisma* spp. Firebrat, *Thermobia domestuica* Golden spider beetle, *Niptus hololeucus* Mexican book beetle, *Catorama herbarium* anobiid beetles (many varieties) Brownbanded cockroach, *Supella longipalpa*
Leather and Parchment	cockroaches (all varieties) carpet bettles (many varieties) dermestids (many varieties)
Other Pests	mice, *Mus musculus* rats, *Rattus* spp. birds, particularly pigeons, sparrows, blackbirds, grackles, and starlings variety of bird mites (from bird nests) fleas, *Ctenocephalides* spp. bats, many varieties

to traps, monitoring will include the examination of staff and public areas for signs of insect or pest activity (such as frass, droppings, eggs) and the examination of the collections for signs of damage. Constant monitoring of environmental conditions (discussed in another section) will alert you to potential problems. Finally, housekeeping must be constantly monitored.

The second step is to determine what level of insect activity will cause the implementation of control mechanisms. For example, in a paper collection a single cockroach or silverfish may warrant attention, while one field cricket may not. These are institutional decisions which need to be based on a knowledge of pest behavior, the nature of the collections, and the level of "acceptable" damage.

The third step involves treatment. One of the most effective approaches is to ensure that pests do not achieve a toehold in your institution. There are two fundamental goals:

- *build them out* (eliminate easy access), and
- *starve them out* (deny them food sources).

Both cultural and mechanical approaches are essential in making an IPM program work.

Cultural modifications include such concerns as thorough cleaning (eliminate food and drink), temperature and humidity control (low temperature and humidity deter pests), grounds maintenance (eliminate flowers and organic mulch next to the library), and lighting (replace ordinary exterior lights with high pressure sodium lights), all of which can make life in and around a library less inviting to pests. Mechanical modifications will be dealt with in this chapter at greater length.

The final step in the IPM plan is continued surveillance to determine population level reductions and the need for additional treatment. If chemical treatments are necessary, the IPM program will analyze available pesticides and determine appropriate types, levels of application, and specific needs.

When restricted use pesticides must be used it is essential that the library be part of the planning process. First, ask your applicator what chemicals are being used and why these materials were selected. Second, obtain from your applicator copies of the label and the appropriate material safety data sheet (MSDS) -- you have a right to obtain both. Third, be present during each application -- walking the applicator throughout your library. And fourth, require that you be given written documentation of each application (a sample form is found as Appendix III). All of these steps will help make your library a safer, healthier environment.

IPM and Building Programs

One goal of IPM is to "build pests out." This process begins with the site work and progresses throughout construction.

Site Grading and Termiticide Treatments

Perhaps the first opportunity the library and architect have to control a pest problem is during site work. ***Keep the site area clean of scrap wood and other organic materials that can support subterranean termites. Be sure no organic materials are incorporated into the building fill.***

All new construction should have what is called a termite pre-treatment. For slab construction two treatment episodes will be needed. The first will be after footings have been poured (except for monolithic slabs, discussed below) and the concrete block or footing is laid, but not capped. Typically termiticide will be applied at the rate of 1 gallon per 10 square feet of slab area. If the area is to be covered with gravel or other coarse aggregate, usually $1\frac{1}{2}$ gallons per 10 square feet will be applied. Foundations and other critical areas (such as piers, plumbing and utility services, and expansion joints) are often the entry point for termites; these areas will be treated a rate of 4 gallons per 10 linear feet. Uncapped masonry wall voids will be treated at the rate of 2 gallons of termiticide solution per 10 linear feet. If the voids have already been sealed (and they should have been left open for this treatment), the applicator will have to drill and inject termiticide. After the final grading is complete, the pest control applicator should return to the library site and treat the exterior of the foundation with trenching or rodding techniques. If trenched, termiticide will be applied at a rate of 4 gallons per 10 linear feet. If rodding, the holes should be spaced no more than 12 inches apart to create a continuous barrier around the structure. Rod holes should not extend below the top of the footing.

In monolithic slab construction treatment is basically the same, except that the initial treatment is performed after the forms are in place, but before the concrete has been poured and no moisture barrier or wire has been laid. The exterior perimeter will be treated when the forms have been removed and the final grading is complete.

Effective termite pre-treatments are essential to the safety of the building, its furnishings, and the library collection. While your local jurisdiction may require a bid process for this work, you should insure that all bids are based on adequate performance and appropriate dilution/application rates of the pesticide. There are documented cases in which the low bid was less than the cost of the termiticide to treat the building, giving rise to the suspicion that an inadequate job was performed.

Good Design and Construction Practices

"Building pests out" requires good design and construction practices -- this means that your architect, general contractor, and job foreman clearly understand what you expect. It also requires attention to detail and liberal use of the punch list (discussed in the concluding section).

Exterior doors - make sure all exterior doors use self-closing devises to limit the time they are open. Fit gaskets and sweeps on doors to minimize insect entry through crevices (remember that an opening as small as ¼ inch will allow a mouse to gain entry to your library).

Windows - make sure all windows close tightly. Any windows that will be openable must be fitted with a minimum of 20 mesh screen (most screen is 16 mesh and will allow access by carpet bettles). All window openings must be tightly caulked.

Utilities - all openings for utilities (water, gas, electricity) must be tightly caulked or otherwise sealed. This includes entrances from the exterior and all interior penetrations (for example in restrooms).

Air Intake Vents - all intake vents for HVAC air handlers or other vents must be screened.

Air Conditioner penetrations - these, and any other penetrations of the exterior wall, provide an entry point for a wide variety of pests. They should be carefully sealed.

Eaves and Ledges - these areas should be eliminated from designs to exclude perching and nesting areas for birds. If eaves and ledges are included in the building design, they should be screened or protected to deter birds.

Exterior walls - all cracks and crevices should be sealed to prevent insect access. Weep holes and wall vents should be screened.

Interior walls - wall cracks and crevices, particularly around baseboards, should be sealed with caulk to deny egg laying or pupation sites to insects.

Interior pipe chases - a variety of water pipes, electrical conduits, and duct work will typically span the structure in all directions, often penetrating walls. These pipe chases are highways for insect and rodent movement, especially when they are hidden by dropped ceilings. All such penetrations must be caulked. If the penetration is through a fire wall, the caulk used must be rated for this application.

Interior wall voids - these areas should be treated, during construction, with a long lasting silica aerogel (one example, which also contains pyrethrin, is Drione® by Fairfield American Corporation). This pesticide will control a variety of library pests, such as cockroaches and silverfish, for very long periods of time and, being placed in a wall void, will keep the pesticide away from patrons and staff. It is also possible to install small plastic tubes in the walls to allow periodic re-treatments of these voids once construction is complete (one example is the Insider™).

High moisture areas - too often the potential for rot (and pest problems associated with the accompanying moisture and mold) is ignored by builders. Wood in areas with a high potential for rot (around plumbing, in outdoor contact with concrete, and so forth) should be treated for rot and decay resistance.

Water control - gutters, downspouts, scuppers (as appropriate) should be operable and channel water at least 10 feet away from the library (preferably into a stormwater drain). Water should never be allowed to collect next to the foundation. Porches, loading docks, entranceways should always be sloped away from the structure to promote adequate drainage. "Flat" roofs should have some fall to avoid water pooling on the surface.

Live Plants - no live plants should be used within the library. For additional information on plants, see the section on Landscaping.

Environmental Controls

Insects typically like warm, moist environments. Unfortunately, that ***warm, moist environment is what too many libraries offer pests through inadequate ventilation, dehumidification, and cooling. Such compromises may not only damage the collection directly, but lead to an increase in pests that can cause additional damage.***

For example, studies have shown book lice feed off the mold that grows on the starchy paper and bindings of books. They are consequently a direct indicator of high humidity levels. Book lice are controlled at relative humidity levels of 50% or less and will be killed by sustained relative humidity levels of 30%. Cockroaches and silverfish are equally susceptible to relative humidity changes.

Housekeeping

A variety of pests, especially a large variety of carpet bettles, flourish in the dust and debris that collect in floor cracks, along baseboards, and in carpets. Cockroaches can survive very well eating the trash that collects in carpets and other small voids. Mold seems to start first on the headcaps of books, where fine dust typically settles and is left undisturbed by patrons and staff.

Anything that promotes better, more thorough housekeeping in libraries will also promote a more pest-free environment. For example:

- eliminate "dust catchers" such as sills and ledges,
- use rounded corners to minimize dust,
- use rounded joints between floors and walls to facilitate cleaning,
- minimize the use of carpet, in favor of hard, inorganic flooring such as tile.

If janitorial equipment is being included in the specifications for the new library, be sure that adequate vacuum cleaning equipment is provided, especially if large areas of carpet are included in the design. An ideal vacuum cleaner will:

- have a strong enough motor to provide excellent cleaning power,
- have a HEPA filter to retain 99+% of particles down to 0.3 microns, and
- be suitable for both wet and dry applications in the library.

Food Services

Since the presence of food attracts a variety of insect pests, the ideal approach is to eliminate food from all library settings. This, of course, may not always be possible. If food is allowed in the building there are a few techniques that can be used to minimize the problem:

Minimize the area where food is allowed. Restrict food to a staff kitchen or lounge. Do not allow food at desks, in processing areas, or elsewhere in the facility.

Separate collections and food. Once food has been limited to one area, design the library so that this one room is isolated from collections and other areas. This can be done by centralizing the lounge or kitchen and keeping it on an outside wall, perhaps in one corner of the library. Then build walls and install doors that will keep pests in this one area. Provide direct access outside, so that garbage can be taken directly to the dumpster and not hauled through the rest of the facility.

Ensure low maintenance. Use tile or other hard flooring, not carpets, where there will be food. Emphasize the use of rounded corners and easy to clean counter tops, tables, and furnishings. Use built-in, rather than free-standing, appliances to reduce cracks and crevices that trap food. Install a small dishwasher to encourage staff cleanliness.

Trash Disposal

The dumpster for the library should be situated away from the building to reduce pest access to the building. The library should also ensure that the drain plug for the dumpster is installed; this will reduce the possibility that rodents will gain access to the dumpster.

SECURITY

Introduction

Library security has essentially two goals: (1) protection of the collection and (2) protection of staff and patrons. One does not, of necessity, follow from the other (for example, preventing the theft of collections will not prevent the robbery or mugging of patrons and vice versa). The major goal of this discussion is related to the security of the collections, although general comments will be offered concerning other security issues as well.

An authoritative guide to security issues is the publication, *Suggested Guidelines in Museum Security*, adopted by the American Society for Industrial Security Standing Committee on Museum, Library and Archive Security. While many librarians may find the guidelines overly rigorous (it is, admittedly, intended for museums), the document provides a threshold against which security concerns can be compared. While not as detailed, the Society of American Archivists' *Archives and Manuscripts: Security* by Timothy Walch may be more familiar to librarians. Architects working with libraries should be familiar with the provisions of both documents and should be able to discuss with their clients the applicability of various features.

These discussions will not cover fire security concerns, found detailed in a previous section.

Foreseeability of Crime

Many security consultants recommend that an institution perform a risk assessment. Part of this process is judging the likelihood that your library will be a victim of crime, whether that means theft of collections, assault of patrons or staff, or vandalism to the structure.

A first step is to assemble information on known losses of library material. This might include information on the known losses by month (to determine if there are more losses, for example, when school is in session), losses by material (are particular books and journals more vulnerable to theft, or more attractive to theft), and losses by range (are most losses coming from areas with little or no security). This information, if possible, should also include mutilation of collections.

A second step is to gather crime information. The police department should be asked to supply information on stranger-to-stranger crimes against persons within one-mile of the library. The library should also evaluate the instance of minor crimes on the premises over the past two years, as an indicator of any problem maintaining order.

Security of Collections

Typically librarians think of collection security in terms of various systems to deter unauthorized removal of books. One such system is the Tattle-Tape● by 3M (excellent discussions of many of the systems available will be found in *Library Technology Reports*). Both by-pass and full circulation systems are available and fairly reliable (although as with any security system, magnetic strips can be defeated by the determined patron). The preservation concern with such systems is the potential damage to the books by inserting the magnetic strip triggers and the adhesive used[1]. Certainly this approach is unacceptable for rare books and special collections. The library's chief concern is certainly the cost of the

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[1] Harris, Carolyn. "The Preservation Considerations in Electronic Security Systems," *Library and Archival Security* 11(1):35-44 (1991).

equipment and the staff time required to arm all of collection.

Coupled with magnetic strips there is usually some need to control movement through emergency exit doors required by the *Life Safety Code* (National Fire Protection Association 101). These doors are typically locked from the outside, but are free opening from the inside. To deter unauthorized use they can be equipped with local alarms that sound when the door is used. In larger institutions, where the staff is unlikely to hear the alarm, it can be wired to a central console, perhaps located at the circulation desk.

Internal arrangements can also be used to deter theft. Circulation, reference, and similar staff areas should be located and designed to allow the staff maximum visibility of the patrons and collections. Floor plans should be developed to ensure clear sight lines are maintained and not blocked by last minute additions or changes. Once provided by the architect, the success of this system is in the hands of the staff, who must be constantly attentive to patrons and their activities.

Theft in special collection areas (such as local history rooms) can be reduced by banning personal possessions, such as pocket books, brief cases, umbrellas, and bulky coats. For this approach to be successful the library must plan to provide free security lockers prior to entering the main library area. There must be adequate signage to enforce the rules and the staff must ensure that all patrons adhere to the posted rules.

Internal arrangements and banning personal possessions are likely most effective in special collections where there are fewer patrons and more strict provisions can be easily established. The key to the security system is the diligence of the staff rather than the sophistication of the equipment.

Some institutions and consultants have recommended the use of closed-circuit television (CCTV) to monitor large libraries and stacks. This is a rather expensive option and most institutions have found that more cameras were required for complete coverage than originally thought. With multiple cameras, there must also be multiple monitors or an automatic switching system. The concept of CCTV, unless intended as an expensive psychological deterrent, requires staff time be devoted to monitoring the various screens -- a thankless and boring task. CCTV systems ultimately fail not because of the hardware, but because of the human element.

Some mutilation and theft of books is caused by patrons being unable to find a functioning copier. The library can reduce this risk by ensuring the availability of adequate, affordable copiers. As discussed elsewhere, copiers produce high levels of ozone and should be vented to the outside.

There are a range of inexpensive psychological deterrents that can be used, including convex mirrors and silvered (one-way) windows between staff areas and public areas. The goal is to create doubt in the mind of the potential thief.

Intrusion Security System

Often called a "burglar alarm," electronic security systems can be as sophisticated as necessary, although such systems also carry a high price. There are a wide variety of systems available and the library should discuss options with the architect. A synopsis of common system components is offered here.

It seems that in today's society, strictly local alarms, which sound only at the institution and require that someone hear the alarm and call the police, provide very little protection and are not worth the investment. ***Libraries should have a system that is monitored 24 hours a day, 7 days a week.*** An annunciator panel can be located at the library, as well as at the commercial central station.

All exterior doors should have magnetic switches, preferably with concealed, rather than surface mounted, contacts. These indicate when there is an unauthorized opening of any door on the premises. If the institution has windows that can be opened (not a good idea because of pest control and HVAC concerns), they too should have magnetic switches that will indicate when a window is opened. ***All glass access points (doors and windows) should have a glass-break detecting device*** such as a vibration or shock sensor. ***An alternative is an interior volumetric motion detection system to sense intrusion.***

Depending on the size of the institution, it may be necessary to use motion detectors to sense movement of people through the library and to detect individuals staying behind after closing hours. These detectors may include ultrasonic, passive infrared, or microwave systems. While dated, the text, *Museum, Archives, and Library Security*, edited by Lawrence J. Fennelly, will provide additional information on the various systems, how they should be designed, and appropriate installation.

While libraries are not museums, there are occasionally special exhibits. Depending on the value of items to be exhibited, the replaceability of the items, the sensitivity of the exhibits to controversy, the ease of the exhibited item's sale, or vulnerability to damage or vandalism, it may be important to include additional security systems specifically designed to protect exhibits.

All libraries should use an alarm system that includes panic buttons for staff use. These can be used if staff observes theft of collections, if a visitor becomes unruly, or if there is some other emergency. Libraries do not typically handle large amounts of cash, and this is fortunate. A study conducted for the American Society of Industrial Security found that 65% of potential robbers are interested in a target if they believe the register contains $100. This drops to less than 25% at $50, and at $30 only 5% of the potential robbers remain interested. Local circumstances should guide the installation of panic buttons at cash registers.

A duress signal capability is recommended for libraries. It can be accomplished using a keypad with a confidential, silent duress code.

Whenever possible alarm systems should be hard wired and fully supervised against tampering. They should be capable of operating for at least 24 hours in the event of a power failure. Electronic communication between the library and the monitoring facility should comply with Underwriters Laboratories Standard 1610, Central Station Burglar Alarm Units and should meet the equipment listing requirements for a Grade AA level of protection service against compromise.

Even the best alarm system can be defeated by human error. All alarms, regardless of frequency or "suspected" cause, must be investigated by a person with security training. Typically this means that either a private security company or the local police should always respond when an alarm is received from the library.

Door Locks and Key Control

The first lines of defense at every library are the door locks. While the presence of the finest locks will not negate the requirements for more sophisticated security systems, they will provide considerable security at a very modest cost.

All exterior doors, and interior doors to sensitive areas (audio-visual storage, vaults, etc.), should have good quality, pick resistent dead bolt locks. A proprietary or regionally proprietary keyway will be used whenever possible. At a minimum the selected locks will use key blanks which are not available through local locksmiths, hardware stores, or other suppliers (this is an essential departure from the local supplier rule followed by most libraries for economic reasons). Room numbers and buildings should never be stamped on keys. Only coded information should be used to identify keys.

One new lock is the DiskLock™ by ABLOY Security Locks (5603 Howard Street, Niles, Illinois 60648). This pick resistent lock uses a key which can be copied only by authorized locksmiths, and then only with a personal key code number.

Coupled with an adequate lock is the need to ensure that doors are securely mounted and that hinge pins, if exposed on the exterior, are not removable.

These first lines of defense are often compromised by the absence of any key control policy. All libraries should establish a written policy with the following, minimal, provisions:

- only one person should be responsible for key control, issuance, and retrieval;

- keys will be distributed only on a documented need basis;

- a set system of key retrieval should be instituted and applied to all employees (i.e., the last two weeks' pay is withheld until all signed for keys are returned);

- locks shall be rekeyed whenever a key cannot be accounted for, is reported lost, is stolen, or cannot be recovered;

- all spare keys will be stored in a secure space or container where they cannot be removed without authorization.

Additional Security Considerations

Some discussion of security concerns offered in the section on landscaping will be briefly repeated in these discussions. Major issues include:

- avoiding the use ofshrubbery around the building, or limiting its use to low-profile plantings;

- ensuring that no landscaping features conceal library entrances or windows;

- avoiding the use of any landscaping features that could be used for vandalism; and

- providing adequate security lighting.

At times it may be important to ensure the staff have clear sight lines to the entrance and building approaches. This may require careful orientation of internal furnishings and work areas. This approach will also provide clear vistas into the building at night, assisting security patrols in their rounds.

Some libraries have requested a "vault" be part of new construction, perhaps for the storage of computer records, microfilm, or other materials. Specially planned security accommodations must be included in the design early. The degree of protection will depend on exactly what is intended to be stored and how much the library is willing to pay. Keep in mind that a vault typically means that not simply must the doors be resistant to attack, but also the walls, floor, and ceiling. Vaults are rated by both the Insurance Services Office (ISO) and Underwriter's Laboratories (UL). Recently, modular vault systems (for use where floor loading is critical) and steel linings (for retrofits) have been developed. Vaults may also require additional levels of fire protection and environmental control.

BOOK RETURNS

Preservation Issues

Preservationists have argued that various book return chutes or drops are "chambers of horrors" for books, although this view has little impressed librarians or patrons. For both, books returns are a matter of convenience and will probably be found in and around libraries for the foreseeable future.

Libraries continue to be built with book returns attached directly to the facility. These are justified by noting they protect books, tapes, and other materials from the excessive heat of exterior return boxes; they protect the materials (and staff) from severe weather; and they allow overworked staff to more quickly deal with returned items. Other institutions use return boxes, located next to the curb, to allow motorists the convenience of returning library materials without the necessity of parking.

All book returns tend to mangle and damage books simply through the process of their sliding into a dead zone and "free-falling" onto some hard surface. Books damage other books as the return area become fuller. Some of these problems can be partially overcome by using spring loaded returns. Libraries can avoid all of these problems with book returns or chutes in circulation used by patrons within the library by simply asking patrons to return books to a designated portion of the counter, avoiding the book return totally. Patrons also can be requested to return books to one of the specially marked shelves found throughout the ranges.

Book returns attached to the library building pose threats beyond the damage to individual volumes. They offer the opportunity for vandalism -- ranging from releasing hundreds of crickets into the library to introducing an incendiary device into the building. A recent example of the latter occurred in Vermont, where a library sustained $11,000 in structural damage and $54,000 in damage to collections from a book return fire (the library did not have either an automatic detection or suppression system and the fire was observed by a passerby).

These problems may be avoided by creating a room or vault into which the books are returned. This room should have fire resistive walls, fire detection, and a fire suppression system. Even if your library does not have a sprinkler system, small, self-contained ceiling mounted automatic halon extinguishers are available for rooms up to 610 cubic feet. The room should be thoroughly sealed from the rest of the building (including screened air vents) to prevent the movement of insects. A floor drain should be provided in case vandals try to flood the building. The door (which should always be closed) leading to this room should have a small glass window so staff can see what might be present.

Book returns mounted outside, away from the building may be less convenient to the staff and may expose collections to hostile environmental conditions, but they are generally safer. They limit the damage that vandals can do at any one time to a very small proportion of the library's holdings. Even here the damage can be limited by providing a drain slot in the return chute in case liquids are poured in. Book returns with a "snuff-out" device can be used to limit damage from arson.

LANDSCAPING

Introduction

Landscaping is typically conducted with aesthetics, not preservation, in mind. While relatively few architects are versed in preservation concerns, even fewer landscape architects are likely to consider immediately the preservation of the collection when designing the features surrounding the library. Even when the landscape architect is sensitive to the issues raised here, this area is often the first place the budget is cut.

Preservation and landscaping are certainly not mutually exclusive. Nor will preservation concerns add dramatically to the cost of the project. By carefully integrating landscape and preservation concerns, long-term costs will likely be reduced.

Vegetation

The benefits of planting trees include their ability to retard wind, provide glare and radiation protection, and contribute toward sound attenuation. Many of these features contribute toward the preservation of library materials and may serve to reduce maintenance costs.

Recent research has shown that trees and woodland parks are the primary biological sinks for air pollutants. The surfaces of trees are effective at trapping particulate pollution, which will eventually be absorbed or washed to the ground. Trees remove gaseous compounds from the atmosphere primarily by uptake through the stomata, although some uptake may also occur through bark pores, absorption of gases through various parts of the plant, and by microbes on the plants. Trees and other plants chosen for urban settings and intended to provide the amenity of cleaning the air must be able to withstand the adverse influences of air pollution (as well as other urban stresses, such as nutrient deficiencies, drought, and microclimatic extremes).

In spite of the benefits, landscape planners should ensure that any plantings (or existing trees) will not overhang the building. Such trees present a danger to the security of collections by encouraging dampness in structural walls; contributing debris that clog roof drains and gutters, increasing the likelihood of leaks; providing an avenue into the structure for a variety of pests, including cockroaches, rodents, and birds; and posing a danger to structural integrity in the event of severe winds.

Ideally, shrubs and organic mulch will never be used adjacent to the library building. The practice of landscaping adjacent to the structure promotes water penetration (through sprinklers) and encourages a variety of pests (such as cockroaches and fleas). If shrubs must be used, an inorganic mulch (such as small pea gravel) is much preferred over organic bark mulches. The gravel offers less harborage for pests, and provides the added benefits of being more durable, cleaner, and requiring less maintenance.

If shrubs are placed against the structure, they should never be allowed to obscure low windows or grow to the size that they provide hiding places for vandals or muggers. Small bushes requiring little or no maintenance are preferred over larger plantings that require constant trimming.

Any shrubs used should be non-flowering. A variety of flowers attract pests (such as dermestid bettles) that are damaging to library collections. By avoiding their use altogether, the library can reduce maintenance costs and pesticide use.

Libraries should exclude all live

vegetation (as well as cut flowers) from interior spaces. Both live plants and cut flowers harbor a variety of pests that can damage library collections. The appropriate location for live plants is outdoors, not in the library.

Water and Drainage

The grades should be laid out to allow water to safely flow away from the structure. Stormwater drains, as discussed in the section on plumbing, should be established to ensure that low points and access areas to the building are adequately drained. Drywells typically do not offer sufficient capacity and are inappropriate for piedmont clay soils.

Vegetation sprinkler systems, when used in the immediate vicinity of the library, should direct water away from the structure, not toward it. The maintenance staff should periodically inspect the system to re-adjust any sprinkler heads that are wetting the building. An ideal solution is the use of below ground soaker hoses, or drip irrigation, rather than sprinklers.

As discussed under plumbing issues, all outdoor spigots or hose connectors should be recessed and lockable. If this is not possible, the library should at least ensure the handles are removed to discourage opportunistic vandalism.

Other Landscape Features

Exterior lighting is considered a necessity for patron and staff safety. Yet in the past a great deal of exterior lighting was used almost solely for the visual enhancement of the library at night. As utility costs increase, this form of light pollution will be curtailed and exterior lighting will again be used primarily for security. Comprehensive security lighting, including the perimeter, structures, and passageways, is probably not necessary at most libraries, although this is a decision to be made based on local circumstances. Lighting should respond to various site hazards, such as ramps, steps, sudden turns, and embankments.

Overhead lighting is more efficient and economical than low level lighting. For pest control concerns, ***lighting should be placed away from the building.*** If the structure itself needs to be lit, up lighting should be used. ***The use of high-pressure sodium lamps is preferred since this type is least attractive to insects.*** In addition, the lamps have a long life span and are economical to operate.

Related to pest control, the landscape planner should design an area removed from the building to place trash dumpsters. By removing this facility from the library building the potential for a variety of pests is reduced. This area may also house a grounds maintenance shed which will ensure gasoline for lawn mowers and pesticides are stored well away from the collections.

Some libraries have integrated fountains and waterfalls into their landscapes. While undoubtedly attractive, such features increase the relative humidity in the vicinity of the library, provide an additional source of water capable of damaging collections, and may encourage vandalism. If fountains must be used, these related preservation issues should be mitigated. For example, water concerns will be lessened if the fountain has adequate drainage and is situated down slope from the library. By removing the fountain from the library building area, concerns over humidity will be reduced. Vandalism may remain a problem, but the removal of the fountain from the immediate library area will probably reduce the risk to the collections should vandalism occur.

Finally, any additional landscape features should be designed to be vandalism proof. Benches and tables should either be too heavy or adequately bolted down to prevent their movement. No materials should be provided near the library that could be used as projectiles.

COST CONSIDERATIONS

Is Preservation Affordable?

For too long preservation has been viewed as a cost, a single line item in a long list of "wants," matched with an ever shortening list of funds. In fact, the question is not "can preservation be afforded?" but rather, "can we afford not to engage in preservation?"

Economics is the prime motivator in determining what the library will incorporate into new construction. Yet, few librarians are sufficiently versed in various methods of cost analysis that can be used to determine the economic feasibility of preservation issues (such as fire detection, or a proper HVAC system, or the installation of water alarms).

While architects are well versed in cost analysis, they are typically not familiar with major preservation issues, the importance of these issues to the library, the benefits derived by the library from adequate preservation planning, or the consequences of poor preservation planning. In addition, it is an unfortunate fact that architectural designs win awards on the basis of issues other than sprinkler systems, dehumidification capability of the HVAC system, or the installation of water alarms. The architect's mind will be on issues other than those essential to preservation. It is up to the library, to remind the architect that preservation is an essential element of the overall building plan.

It is important for those in libraries, and their governing boards, to understand the relationship between the initial cost (or capital cost) and the on-going maintenance costs (or life cycle costs, discussed below). While there are always exceptions, in general a building procured cheaply through intentional design, will have high maintenance costs. In construction, perhaps more than anywhere else in life, the old adage, "you get what you pay for," applies.

Often libraries make this trade-off of building cheaply and maintaining expensively because capital costs are hard to come by; maintenance costs seem easier to obtain; and society wants more for less.

There should be enough horror stories to deter such compromises, but they continue to be made. Many institutions have found the decision to "build cheaply" was short-sighted. While there was an implicit "understanding" or "agreement" regarding the consequences of the decision, after a few years the governing board changed and all previous decisions and agreements were forgotten, although recriminations frequently linger.

It is rarely, if ever, in the best interests of the library to use materials known to have a limited life, accept services that meet only the barest minimum standards, or change out permanent fixtures for impermanent fixtures. The yardstick of "more-for-less" has resulted in nearly 20 years of library building that often fails at meeting minimal preservation standards and needs.

Cost Analyses

In cost analysis the impact of different designs, construction techniques, and equipment installations is examined. The goal is to determine the relative worth of net economic gains of different options compared to the net economic costs.

The library should realize the limitations of cost analysis. The most significant limitation is that cost analyses cannot incorporate benefits which have no clear cost savings. Of course, it is usually possible to at least estimate benefits.

The second limitation is that cost analyses are, in themselves, costly, since they involve the architect's time. Consequently, they should be requested only when justified by the costs involved.

The purpose of this discussion is not to specify the various techniques. If the librarian desires to know more about economic analysis, an excellent text is Norman Baresh and Seymour Kaplan's *Economic Analysis for Engineering and Managerial Decision Making*, Second Edition (1978) published by McGraw Hill. Basic analyses, however, include:

- Life Cycle Costs - calculates all of the costs associated with an option over its life to evaluate expenditures during the period of use.

- Annual Cash Flow Analysis - future sums and present worth are converted to provide uniform annual costs.

- Benefit/Cost Analysis - compares the economic benefits to the costs of the project.

- Payback Period - calculates the length of time required for the benefits from a project to equal the cost of the investment.

The librarian should also realize many, if not most, of the preservation suggestions offered here will not only affect the preservation of the collections, but will also impact the general health and well-being of staff and patrons, improve the appearance of the building, make routine maintenance more convenient, and so forth. In other words, seeking the "pay-back" only in preservation of collections focuses the study too narrowly.

And finally, while the library is encouraged to explore economic analyses, it should be remembered that the "value" of some collections is their representation of our intellectual, cultural, or spiritual past. Converting that value to dollars and cents can perhaps be achieved if the collection is examined only in the context of what it would raise at a public auction, but this ignores the greater value of having the resource available to society.

Preservation and Maintenance

As an example of how preservation can affect other facets of the library, it may be useful to briefly examine the relationship between good preservation and good maintenance, and how the two relate to the building program.

The first aspect is that maintenance costs, when compared to interest charges, salaries, equipment and its replacement, and a range of similar costs, is still relatively low. Some would argue too low, especially since routine maintenance (often overlooked) is much less costly than crisis maintenance. Planned maintenance will ensure that crises, which often threaten the collections, are less likely to occur. This view was presented with eloquent simplicity in 1877 by William Morris in the Manifesto of the Society for Protection of Ancient Buildings: "stave off decay by daily care."

Specifying low or minimal maintenance to your architect can also help the preservation of the collections. There are four significant areas where the "low-maintenance" concept can be especially significant.

The first is in the *building form*. The importance of thermal design and energy efficiency, and how these are affected by the building form, have already been discussed. The library should ensure easy access to all parts of the building for maintenance. For example, pitched roofs are often more difficult to maintain than flat roofs. Skylights and high windows are rarely, if ever, cleaned, lamps in fixtures which require scaffolding to be replaced will likely stay burned out. All of these issues relate to the ease of access. The less likely it is that the maintenance crew will examine a part of the building, the more likely that there will be some failure affecting collections.

The second area of concern is the *building detail*. The axiom that "simplicity is the essence of good design" is particularly important in preservation. The more complex and elaborate the design, the less likely it will be properly executed, the less likely it can be easily repaired, and the more likely problems will eventually affect the collection. Likewise, economies in detail can have serious, and long range, consequences. For example, the failure of flat roofs can usually be traced back to inadequate detailing and specification.

The third area of low-maintenance concern is in *building services*. Mechanical and electrical services typically account for 40% of the total building cost, yet they are hidden from view and often ignored. Often cost cutting measures are aimed at such building services as the HVAC system -- hidden, out of sight and out of mind. Few libraries express much concern over the HVAC system until it fails, or is unable to prevent mold outbreaks every spring. A principal rule of services is they should be adequately specified and installed. Further, they must be easily accessible. Finally, all services should be accompanied by clear, detailed, and accurate operation manuals, as-built drawings, and maintenance schedules.

The final area of concern involves the choice of *materials*. All materials for libraries should be selected with three questions in mind:

- how will the selected material stand up to use?
- how easily can it be cleaned and/or maintained?
- how easily can it be repaired or replaced?

Libraries receive a great deal of wear and tear. Materials should be selected to withstand the demands placed on them and to reduce the level of maintenance required. For example, any exterior woodwork will require painting at least every three years and will have a life expectancy of no more than 15 years. Replacing wood with synthetic materials may be a wise maintenance decision. Likewise, a marble entrance foyer will require much less maintenance, and will last much longer, than either carpet or linoleum.

When cleaning and maintenance are made easier, the building will be better able to ensure the long-term preservation of the collections.

CONSTRUCTION PROCEDURES

Introduction

The goal of this section is to help librarians better understand the process, to know what will be expected of them and what they may reasonably expect of others. This section is also intended to ensure preservation concerns are reinforced throughout the construction process and are not allowed to be forgotten or disregarded. The publication by Lull and Banks, *Conservation Environment Guidelines for Libraries and Archives* provides excellent advice and should be consulted.

Libraries will find the processes of even a small renovation project are essentially the same as those found in the construction of a new facility. There will be some aspects which can be legitimately combined, and this should not be of concern. On small renovation projects there is often the tendency to dispense with the services of an architect, hire a contractor, and have that individual serve, essentially, as the design team. At times this may not be inappropriate, but the library should insist that all of the essential functions of the design team (such as exploring alternative approaches, conducting cost analyses, producing detailed drawings and specifications) are completed by the contractor. Architects can serve a valuable oversight function, ensuring the contractor adheres to the design specifications.

Developing a Building Program

It is the responsibility of the library to clearly outline its needs and the goals of the proposed building or renovation program.

This process should be carefully considered and have the input of all staff levels. Unfortunately, too often the building program comes from the governing authority, which often has little knowledge of daily library needs, much less preservation goals. Consequently, while the final building plan may come from the governing authority, it should originate from the staff level. In larger institutions it is appropriate to form a committee, incorporating individuals from all of the various departments (technical services, public services, maintenance, and so forth).

The building program should not only indicate what the library wants, but should also indicate essential elements and place bounds on the future architectural design team. For example, the executive summary of this document can be incorporated into the building plan to clearly outline the essential elements of preservation. It is essential that the building program be a written document covering all of the building features the committee feels are important. Nothing should be left to memos, letters, "understandings," or verbal agreements.

Programming consultants, often architectural firms with specialized experience in library construction, may be used at this stage, to help clarify issues and interpret needs.

This may include a feasibility study, during which the programming consultant takes the library building program and compares the expressed needs with the available money. The outcome is that the library must decide to abandon, modify, or proceed. It is at this phase many qualitative decisions are implicitly made, although little, if any, actual design work is made. Consequently, it is at this early phase preservation can face its first battle as it will come under attack to save money.

Many experts believe architectural firms working with the library at this stage should not go on to prepare the design, but rather should be retained, as necessary, to review designs and help assure the library the designs are consistent with the original intent of the building plan. This division ensures checks and balances in the design process which can ultimately work to the library's benefit. On the other hand, it often makes sense to have the same firm do both programming and architectural work because of the cost, efficiency, and expertise of this approach. Regardless, it is important to establish a budget which is coordinated with the developed program. This will become the design instrument and control for the building program.

Selecting the Design Team

Depending on the size of the job, the design team may consist of a variety of architects and engineers. ***The design team will serve as the library's principal agents in the design and construction process and must consequently be carefully selected.***

Under some conditions the library may solicit letters of interest and accompanying qualifications statements. At other times the institution will use its building program document to solicit proposals. Design competitions, where awards are usually made solely on architectural merit by individuals with little or no library experience, can saddle the institution with a building that is not only impractical, but also fails to meet even the most minimal preservation standards. This approach should be avoided by the library.

Likewise, some institutions may seek the services of a high profile design architect, hoping that this individual's involvement will help to raise funds for the project. The down side of this approach is the high-profile architect may be overly interested in creating an award-winning design with the associated construction costs being passed on to the library.

Libraries may find there are a variety of very capable and practical local architects who can provide excellent services. ***While previous experience in library design is usually a plus, the library staff would do well to visit, or at least talk with, staff at the other libraries an architect has designed.*** This is particularly useful to ensure preservation concerns were integrated into the design, and appropriately achieved during construction. Even a recognized library architect can fail to understand the importance of preservation.

The Design Process

Regardless of how the design team has been selected, its functions should always be the same. ***Most importantly, the library should take the lead in its relationship with the design team, rather than blindly following recommendations.*** The design team should serve, not dictate, the needs of the library and should constantly recognize that the library is the client who makes the decisions. The goal should be to design and construct a functional library capable of preserving library materials, not winning an architectural award. ***Aesthetic goals must never be allowed to compromise the preservation of collections.***

The American Institute of Architects recognize five basic phases:

- schematic design phase,
- design development phase,
- construction documents phase,
- bidding or negotiation phase, and
- construction phase (discussed in a following section).

In the schematic design phase the architect reviews the building program developed by the library (or by the library and programming consultants, if different from the selected firm). The project budget may again be compared to the building program.

In this phase the library should insist that a wide variety of options be explored --

calling on the greatest creative imagination of the team. One of the major problems is too often the design team will examine problems only from the perspective of how those problems have been solved in the past. There cannot be too many ideas, especially if they are sensitive to preservation.

The outcome of the schematic design phase will be documents and drawings indicating the scale and relationship of the project components, as well as a very preliminary estimate of construction costs. These must be carefully reviewed and approved by the library, especially if there are any major changes to the intent of the building program.

Next will be the design development phase. Taking the approved schematic design documents the design team will prepare documents and plans which fix and describe the architectural, structural, mechanical, and electrical systems and materials.

During this process a three-dimensional framework for the project is developed. Each of the various design ideas previously developed is further explored, life cycle costs are calculated, computer models and simulations will be run, and the various ideas will be either eliminated or refined for integration into the final design.

In these early stages the library should expect frequent (perhaps weekly) reviews of the design team's progress. As time passes the design becomes clearer and hence easier to work with, but it also becomes less flexible, and changes become more costly. The library will want to keep in very close touch with the design team and ensure that preservation concerns are consistently integrated into the planning. While not all systems will be detailed early in the process, the library should expect some fairly concrete narratives of how systems will be designed, how they will operate, and how they will be budgeted. Hearing the words, "Oh, we will work out how to ensure humidity control later," is a sure sign the process is off-track and needs immediate and drastic revision. Too frequently "later" will never come, or it will come when there is no money left in the budget.

The library should continue to maintain control of the design process. The institution should insist the design team fully explain all issues and intelligibly answer all questions. The library staff should only accept designs when they are totally comfortable with all of the features and aspects. Until then the staff should continue to ask questions.

During this process the design team will refine the construction budget prepared as part of the schematic design phase. The library should insist this budget reflect the priorities in design and preservation issues (such as an adequate HVAC system, a sprinkler system, or adequate light control) not be hidden elements that can be easily cut later. The library should require the design team to develop a budget contingency plan that outlines what will be cut, if cuts are necessary at a later stage. Only through this process can the library be relatively certain that essential preservation concerns are not eliminated later in the process.

Throughout these processes the library must remain alert to the needs of preservation. While intended for larger libraries, public institutions can also obtain considerable assistance from Leighton and Weber's *Planning Academic and Research Library Buildings*, published by the American Library Association. The discussion of "The Review Process" is particularly useful and will help institutions to examine the preliminary and schematic designs with a more critical eye. It is also helpful during these stages to ask the design team preservation questions (such as, "Where, exactly, is the sewage cleanout valve located?").

During the construction documents phase the design team will take the previously generated information and transform it into construction documents, including drawings and specifications, which establish the requirements for the construction of the project.

Broadly speaking the design team will be working on three types of products:

- drawings, which show where things are, how they are arranged, and how they are put together,

- lists of quantities, which indicate how many things will be used and the labor involved translated into costs, and

- specifications, which document the nature and quality of the proposed materials.

Of these three, the specifications are often the most important from a preservation standpoint. The goal of the specifications is to define the quality of the materials going into the project, the level of workmanship expected, and the quality of the finished product in such a way that the library, the architect, the contractor, and the subcontractor can all agree on what is meant and determine whether it has been provided. It is very important that librarians not "skip over" the mass of written specifications.

The phrase, "or equal," will often be seen in the specifications, whether the items are paint, or chairs, or roofing. While there are some legitimate reasons for this approach, there are also serious pitfalls. One of the greatest is determining if, in fact, various products are equivalents. The library should be alert to the practice, especially since the use of alternatives may be an easy way to cut costs and bring the job in "on budget." The design team can evaluate substitutions proposed by contractors, but this is an additional service which requires additional compensation.

The design team will assist the library in the preparation of bidding information, bidding forms, contract conditions, and the agreement for use between the library and the selected contractor.

The bid documents include those items to be sent out to potential contractors for the bid process. The library should carefully review this package, since these documents reflect the structure and systems the library will be living with for the next several decades. At this stage the design work is complete, and all of the design funds have been spent by the architect. In spite of this, design is always less expensive than construction and if there are problems it is always better to stop the process than to build an unacceptable structure.

The bid package should include several important features often overlooked. The first is a provision for a ***stable performance test period***. This allows the building and its services to be tested for a certain period of time (perhaps six months) to assure that all are working properly. This provision should apply to major elements, such as the HVAC system, the roof, piping, drains, or any features where failure could threaten the collection. The bid package should indicate the systems covered, the length of time, and the criteria for acceptable performance. The contract should specify that only after the successful completion of this stable performance test period will the library give final acceptance on the building (have your attorney examine this provision from the perspective of "beneficial occupancy" and have the contract correctly worded). While some contractors may decline to bid, this should not dissuade the library. Other contractors will be found.

The bid package should also require the contractor to provide complete system documentation, including:

- copies of the as-built plans (usually submitted as marked-up prints),

- copies of all shop drawings,

- all service manuals and operating instructions, and

- copies of all warranties and associated information.

The library may also wish to pay the design team to prepare additional information covering the daily operation of the building services, emergency shut-downs and start-ups, and essential maintenance procedures.

In the bidding or negotiation phase the design team will help the library actually obtain bids or negotiated proposals, and assist in awarding and preparing contracts.

The Construction Process

The construction process typically includes the actual construction. During this phase the design team is usually responsible for the administration of the Contract for Construction. The architect or other member of the design team will periodically visit the construction site. The purpose of these visits is to become familiar with the progress and quality of the work, but not to engage in exhaustive inspections.

Libraries should strive to break the monopoly of "low-bid." While construction consists of concrete, steel, and wood, it also involves skill, previous experience, and ingenuity. The former can be "low bid," the latter cannot. It is much more effective to select a middle bid and expect that firm to provide careful attention to construction details.

The design team (particularly the architect and engineer) can be retained to make more frequent inspections of the construction site than is normally anticipated under standard agreements. This will better ensure that the design is being properly executed and the materials being used are those specified. The design team, paid for this service, will be acting as the agent of the library, protecting its interests and ensuring that preservation issues and concerns are understood by the contractor and subcontractors. Exactly how often these "periodic" visits are should be carefully specified -- a lot can happen during a week on a construction site.

Even with periodic inspections by the design team or architect, it is still essential that the library pay careful attention to construction details and practices. One excellent source of information on this is Rebecca Thatcher Ellis' paper, *Getting Function from Design: Making Systems Work*, delivered to the 1991 meeting of the Society of American Archivists, copies of which are available from the Northeast Document Conservation Center (listed in the Resources section). Librarians, however, should realize that the normal communication route with the contractor is through the architect.

Inspection, Moving In, and Shake Down

There comes a point in construction referred to as "substantial completion," when the library construction is more or less completed. At this point the library staff (often with the design team) should make a very careful inspection of the facility, preparing a "punch list." This punch list should cover any flaws in construction, deficiencies, or omissions. It can range from a flawed paint job, to inappropriate door sills, to the failure to install dampers, to a missing electrical outlet or cover plate to leaking pipes. The institution may also wish to bring their programming consultants back into the loop at this stage, to participate in the building review.

The importance of this punch list cannot be overstated. It is essential the library cover all visible problems at this stage. The issues should be legitimate, and the library should expect satisfaction. Naturally, the library will be holding a major retainer on the contractor to ensure that the problems are corrected.

It is also at this stage a variety of building services will be independently tested. For example, the HVAC system will be subjected to an independent test and balance by an independent certified test and balance engineer (usually not the mechanical engineering firm that installed the equipment). The fire detection and suppression system will also be independently tested and certified. The design team engineer should review these tests.

At this point the library will want to obtain all of the system documentation (such as shop drawings, as-built drawings, manuals, warranties, and so forth) from the contractor.

Only after all of the punch list items are corrected, all of the documentation has been provided, and the stable performance test period is complete, should the library agree to the final acceptance of the building. It is important to realize that once this final acceptance has been given, the contractor's retainage (usually 2 to 20%) is released and he will lose considerable interest in any problems the facility might face. To solve any problems after final acceptance the library must rely on warranties, good faith, or legal action -- none of which offer a great deal of hope.

Ellis' article, *Getting Function From Design: Making Systems Work*, is again an excellent source for libraries which want to insure that systems function as designed.

The April 1992 issue of *American Libraries* offers several articles on the logistics of moving a library. To these comments it is important to stress the preservation needs of the collection even during the move. For larger institutions it is likely volunteers will help pack and move. Be sure books are packed with preservation in mind, taking care not to damage materials. Packed books should be moved as quickly as possible and should be protected from weather throughout the transfer.

The Northeast Document Conservation Center also has prepared excellent advice for institutions which are undergoing renovations (*Vulnerability of Collections During Renovations*). In general there are several major areas of concern:

- protection of the collections from wet trades, such as plumbing,
- protection of the collections from water damage, such as plumbing or roof repair,
- protection of the collections from direct construction damage, such as falling debris and tools,
- protection of the collections from both particulates (dust and grit) and gaseous pollutants (glues and similar solvents),
- protection of the collections from increased fire hazards caused by construction, and
- protection of the collections from an increased security threat (theft, mutilation).

The new library should also be purged to remove construction off-gassing, construction particulates, and construction moisture. This may be accomplished by running the HVAC system for several weeks before collections arrive (but after all construction is completed) and replacing filters before the collections are moved. All floors, counter tops, and book shelves should be washed or mopped (not just brushed or dusted) during this stage.

For the stable test performance period to be of any use, the staff must be constantly alert to problems, however minor. Leaks after heavy rains, fluctuating humidity or temperature, condensation on pipes, and so forth, must be noted in an events log and brought to the attention of the contractor, in writing, for repair or replacement of equipment. The library should also undertake 24-hour monitoring of environmental conditions using a recording hygrothermograph. This will help document environmental problems and may assist in tracking down the cause. If there is an overwhelming "new" smell in the institution, in spite of requirements to use low-emission products, the library should conduct formaldehyde monitoring.

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Preservation Assistance

Chicora Foundation, Inc.
PO Box 8664
Columbia, SC 29202
803/787-6910

Northeast Document Conservation Center
100 Brickstone Square
Andover, MA 01810
508/470-1010

Southeastern Library Network (SOLINET)
Preservation Field Services
1438 W Peachtree St, NW
Suite 200
Atlanta, GA 30309
800/999-8558
Publisher of *Environmental Specifications for the Storage of Library and Archival Materials*

South Carolina State Library
Network Services
PO Box 11469
Columbia, SC 29211
803/734-8666

The Building Envelope

National Institute of Building Sciences
1015 Fifteenth Street
Washington, DC 20005
202/347-5710

U.S. Department of Energy
Office of Scientific and Technical Information
1000 Independence Avenue
Washington, D.C. 20585
202/586-5000

Roofing

National Roofing Contractors Association
86 Bryn Mawr Avenue
Chicago, IL 60631
708/299-9070

Roofing Industry Educational Institute
14 Inverness Drive E, Bldg. H, Suite 110
Englewood, CO 80112
303/790-7200

Lighting

Illuminating Engineering Society of North America
345 East 47th Street
New York, New York 10017
212/705-7900
publisher of the *IES Lighting Handbook*

National Lighting Bureau
2101 L Street, NW
Washington, DC 20037
202/457-8437

Canadian Conservation Institute
1030 Innes Road
Ottawa, Canada K1A OM8
613/998-3721
CCI Notes 8, *Ultraviolet Filters for Florescent Lamps*
CCI Technical Bulletin 7, *Fluorescent Lamps*

Heating, Ventilation, and Air Conditioning

Air Conditioning and Refrigeration Institute
1501 Wilson Blvd.
Arlington, VA 22209
703/524-8800

National Center for Appropriate Technology
PO Box 3838
Butte, MT 59701

The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
1791 Tullie Circle, NE
Atlanta, GA 30329
404/636-8400

Fire Safety Design

National Fire Protection Association
1 Batterymarsh Park
PO Box 9101
Quincy, MA 02269
800/344-3555

Southeastern Library Network, Inc. (SOLINET)
Preservation Field Services
1438 W Peachtree St, NW
Suite 200
Atlanta, GA 30309
800/999-8558
Publisher of *Can You Stand the Heat: A Fire Safety Primer for Libraries, Archives, and Museums*

Southern Building Code Congress International, Inc.
900 Montclair Road
Birmingham, AL 35213
205/591-1853
Publisher of the *Standard Fire Prevention Code*

Security

American Society for Industrial Security
Standing Committee on Museum, Library and Archives Security
1655 North Fort Myer Drive
Suite 1200
Arlington, VA 22209
703/522-5800

Other Useful Addresses

American Association of Museums
1225 Eye Street, NW
Suite 200
Washington, DC 20005
202/289-1818

American Assoc. of State and Local History
172 Second Avenue North
Nashville, TN 37201
615/255-2971

American Institute for Conservation of Artistic and Historic Works
1400 16th Street, NW
Suite 340
Washington, DC 20036
202/232-6636

American Institute of Architects
1735 New York Avenue, NW
Washington, DC 20006
202/626-7300

American Library Association
110 Maryland Avenue, NE
Suite 101
Washington, DC 20002
202/547-4400

American National Standards Institute
1430 Broadway
New York, NY 10018
212/354-3300

American Society for Testing and Materials
1916 Race Street
Philadelphia, PA 19103
215/299-5400

Association of Research Libraries
1527 New Hampshire Avenue, NW
Washington, DC 20036
202/232-2466

Building Research Institute
2101 Constitution Avenue, NW
Washington, DC 20418

Commission on Preservation and Access
1785 Massachusetts Avenue, NW
Room 313
Washington, DC 20036
202/483-7474

Construction Specifications Institute
601 Madison Street
Alexandria, VA 22314
703/684-0300

Earthquake Engineering Research Institute
6431 Fairmount Avenue, Suite 7
El Cerrito, CA 95430
414/525-3668

Factory Mutual System
1151 Boston Providence Turnpike
Norwood, MA 02062
617-762-4300

Library of Congress
Office of the Assistant Director for Preservation
101 Independence Avenue, SE
Washington, DC 20540
202/707-1840

National Archives
Preservation Services Division
7th & Pennsylvania Avenue, NW
Washington, DC 20408
202/523-3220

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

Society of American Archivists
600 S. Federal Street
Suite 504
Chicago, IL 60605
312/922-0140

Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, IL 60062
312/272-8800

APPENDIX I.
USING A CAMERA LIGHT METER TO MEASURE LIGHT LEVELS

1. Place a sheet of white cardboard (foamcore or similar material) measuring 12 by 16 inches at the position where the light level is to be measured. Measurements should typically be taken on a horizontal plane at the work area or area of concern.

2. Set the camera film ASA rating to 800 and the shutter speed to 1/60 second. If the camera has a switchable spot/averaging meter, switch it to the averaging mode.

3. Aim the camera at the white board and position it so that the entire viewfinder is filled by the board.

4. Adjust the f-stops until the meter indicates a correct exposure.

5. The approximate lux level at the white board:

f4 - 50 lux
f5.6 - 100 lux
f8 - 200 lux
f11 - 400 lux
f16 - 800 lux
f22 - 1600 lux

Data obtained from Canadian Conservation Center Notes 2/5, *Using a Camera to Measure Light Levels*.

APPENDIX II.
LOW-UV FLUORESCENT LAMPS

	Color Temp. (° K)	UV Emission (μW/lumen)	Color Rendering Index	Lumen
Phillips F40				
Warm White 29 *	2950	70	53	3100
Warm White Special Deluxe 27	2700	33	94	1700
Cool White Special Deluxe 37	3850	33	96	1700
Color Matching 47	5000	33	98	1830
Westinghouse F40				
Ultralume 3000	3000	59	85	2900
Ultralume 4100	4100	47	85	2900
Ultralume 5000	0500	51	85	2900
Verilux F40				
Full Spectrum VLX/M	6200	47	high	1984
Verd-A-Ray F40				
North White Fadex	5100	46	91	2740
Criticolor Fadex	5700	52	91	2120
DSW 30	3000	56	N.A.	1860
Sylvania				
Incandescent-Fluorescent	2700	50	90	1600
Warm White **	N.A.	45	N.A.	2880
Cool White **	N.A.	56	N.A.	2835
General Electric F40				
Warm White	N.A.	75	N.A.	3150
Warm White Extra **	N.A.	72	N.A.	3279

N.A. - not available
Data obtained from Canadian Conservation Center Technical Bulletin 7, *Fluorescent Lamps*

** Data presented by William P. Lull, Garrison/Lull, *Private Monograph on Selecting Fluorescent Lamps for UV Output*, 1992

* Lull's most recent data (cited above) lists the UV of this bulb at 101 μW/lumen, illustrating that the UV output of fluorescent lamps can significantly change as the design and coatings change. Consequently, before selecting a lamp, the library should assure itself that the UV emissions are acceptable.

APPENDIX III.
PESTICIDE APPLICATION RECORD

Building: ______________________ Date: ______________ Time: __________

Room(s) and Area(s) Treated: ______________________________________

____

____

____

____

____

Reason for Application (Insects): ___________________________________

____

____

Pesticide Used (Name and Amount of Active Ingredient): ______________

____

Dilution Used: ____

Total Amount Used: ____

MSDS and Product Label on File: ______________________________

Method of Application: _______________________________________

____

Unusual Safety Measures/Requirements: _________________________

____

Any Problems Encountered During Application: ___________________

____

____

Applicator: ______________________________

Firm, Address, Telephone Number: ______________________________

____

Signed: ______________________________

APPENDIX IV.
CHECKLIST OF PRESERVATION CONCERNS

The Library Site

☐ The architect must incorporate adequate protection against natural events, such as:

- ☐ a wind resistant building design,
- ☐ seismic resistant construction, and
- ☐ flood resistant design features.

☐ The library must take additional measures to secure the collections in the event of:

- ☐ earthquakes (e.g., bracing shelving),
- ☐ hurricanes (e.g., window protection),
- ☐ tornadoes (e.g., limiting roof mounted equipment),
- ☐ thunderstorms (e.g., adequate lightning protection), and
- ☐ flooding (e.g., adequate drainage).

☐ The range of man-induced disasters that might reasonably occur at the library site should be examined including:

- ☐ transportation patterns (highways, railroads, airline flight paths),
- ☐ nearby industrial, commercial, and support facilities (nuclear power plants, fossil fuel plants, electrical substations, chemical plants, hazardous waste facilities, penal institutions, possible terrorist targets), and
- ☐ domestic risks and crime statistics (with special attention on stranger-against-stranger violent crime).

The Building Envelope

☐ Select the library site to minimize exposure to wind, rain, and other elements.

☐ The orientation of the structure should maximize thermal efficiency while ensuring the preservation of the collection.

☐ Smaller, heavyweight structures are more efficient and better at maintaining a preservation environment than large, open, and lightweight construction.

☐ Wasted spaces should be eliminated and design minima should be carefully justified.

☐ The building envelope must be made as airtight as possible, with special attention given to doors and windows.

☐ The architect should conduct thermal evaluations of his design options at any early stage in the planning process.

☐ The building envelope should be

designed with other preservation concerns in mind.

☐ During renovations the library should instruct its architect to explore ways of improving the thermal efficiency of the structure. Even simple methods, such as caulking and repair, may help save funds and reduce HVAC costs.

The Library Interior

☐ The library must be designed and constructed using materials that minimize sources of formaldehyde. This should include:

> ☐ using plywoods that have phenol-formaldehyde glue and avoiding all urea-formaldehyde formulations,
>
> ☐ avoiding the use of particle board in construction,
>
> ☐ carefully selecting adhesives to minimize or eliminate off-gassing, and
>
> ☐ selecting finishings, particularly carpets (if used), to minimize or eliminate off-gassing.

☐ The library should emphasize the use of safe acrylic and carefully selected latex paints, avoiding the use of all oil-based paints.

☐ Moisture-borne or latex-type polyurethanes are acceptable. Oil-modified urethanes should not be used.

☐ The use of wood shelving is strongly discouraged. There are no adequate means of making wooden shelving totally safe for collections.

☐ Enamelled steel is acceptable if the manufacturer has ensured adequate baking of the paint. If any odor is detected from the shelving or cabinets, it is likely off-gassing and should not be accepted for use with collections.

☐ For special collections the library may wish to use powder-coated steel, which provides a more consistently inert coating.

☐ Fabrics for use in displays should be carefully chosen to minimize the collection's exposure to corrosive material.

☐ Test for the presence of off-gassing if in doubt.

Flooring

☐ A major preservation consideration with all floor coverings is the off-gassing of the adhesives. Consequently adhesives must be selected which are non-toxic, contain low levels of VOCs, and are quick-curing.

☐ A good choice for floor covering is vinyl. This is best applied in a roll, rather than as tiles, since there will be fewer cracks to collect soil.

☐ Carpet is a poor preservation choice for a variety of reasons. If it must be used, a synthetic is preferred to wool for pest control reasons.

☐ Floor loading is an important engineering concern of all library construction. It is important to plan for expansion or re-arrangement of collection areas prior to the design of a new library. It is also important to consider whether compact, high-density storage is likely to be used in your facility since these storage systems require significantly greater structural load bearing capacity.

Roofing

☐ Either a pitched or flat roof may be safely used with libraries, if:

☐ it is appropriately designed with attention to materials, serviceability, and drainage,

☐ it is correctly installed, and

☐ it is adequately maintained.

☐ Where a pitched roof is used, appropriate roofing materials include:

☐ slate and tile,

☐ metal shingles,

☐ metal sheet materials,

☐ premium grade asphalt fiberglass shingles.

☐ Where a "flat" roof is used, either membrane or built-up roofing is appropriate, although the designer must pay particular attention to:

☐ drainage,

☐ transmission of water vapor and formation of condensation, and

☐ resistance to the wear anticipated.

☐ Although quality assurance and quality control are significant throughout the construction trades, they are especially essential in the selection and installation of the roofing material.

☐ Libraries must emphasize the necessity of on-going inspection and maintenance of roofing systems.

☐ Libraries should request the architect perform life cycle costs and cost/benefit analyses of various roofing options.

Electrical and Plumbing Concerns

☐ All electrical work is to comply with the latest edition of the National Electrical Code, as well as any local codes.

☐ Ground Fault Circuit Interrupters must be included throughout the building (including the stack areas) and appropriately labeled.

☐ The main electrical service disconnect must be located within easy access to the staff and clearly marked. Instructions must be provided for both the main disconnect and the disconnect of individual circuits. All circuit breakers must be clearly labeled.

☐ The library should investigate needs for emergency power. All essential electrical safety requirements outlined in the *Life Safety Code* (National Fire Protection Association 101) as well as fire and security systems must be powered by batteries or batteries and invertor. The library should explore the need for an uninterruptable power supply for computers. This will allow an appropriate shutdown of computers in the event of a power outage.

☐ During renovations all electrical transformers and capacitors must be checked for the presence of PCBs. Plans for removal should be made and PCB containing equipment must be labeled.

☐ The institution should investigate the need for surge and lightr ng protection.

☐ Libraries should avoid below ground construction because of possible water and moisture problems. If such construction is unavoidable, the library must require waterproofing and drainage of below grade levels.

☐ The landscape must be graded away

from the building, with at least a 1% slope. Adequate stormwater drains must be provided, especially for low areas and the areas around doors.

☐ Water lines should not be run above collection/stack areas. If unavoidable, the designer must incorporate appropriate mitigating techniques.

☐ Overhead piping, if used, must always be adequately insulated (with a vapor barrier) to prevent condensation.

☐ If the use of sump pumps is necessary, provisions must be made should the pump or electrical power fail.

☐ All water disconnects must be clearly marked and the staff must understand how to turn the water off in the event of an emergency.

☐ Drains, with backwater valves, must be installed wherever there is a water hazard in the building. These areas include bathrooms, janitorial closets, mechanical rooms, and hot water tank areas.

☐ Sewer cleanouts must never be located in stack or collection areas.

☐ All spigots, both outside and in public areas of the building (such as bathrooms), must be vandal proof.

Lighting

☐ Remember that low-intensity light of high quality (avoiding glare, providing good color rendition, and having appropriate contrast) is always better than high-intensity light of poor quality.

☐ Light levels of 550 lux represent the upper limit for virtually all library activities and levels of about 250 lux have been shown to be adequate for stack areas and general reading rooms.

☐ Closed stacks can have lower light intensities and lights should be wired so that lighting on individual ranges can be independently controlled. Where a number of lights are (or must be) controlled by one switch it is possible to install an automatic timer (for both incandescent and fluorescent fixtures) that will allow staff time to obtain the necessary item but will automatically turn off the lights.

☐ While daylight can be used, w... precautions, for ambient lighting, it must never be used for task lighting. Daylight must also be avoided in collection areas.

☐ Skylights and clerestory windows are poor preservation choices since condensation is likely to be a problem and cleaning is very difficult.

☐ It is helpful to create transition zones between bright, ambient lighted public areas and stack areas with lower illumination.

☐ Tungsten-halogen and various HID lamps are not good preservation choices since they produce significant UV levels and relatively high temperatures.

☐ Both filtering and use of low-UV lamps offer adequate and appropriate options to reduce the UV levels associated with fluorescent lighting. The choice is dependent upon local cost and maintenance considerations.

☐ Special collection areas must receive even more careful attention to the damaging effects of light than general collection areas.

Heating, Ventilation, and Air Conditioning

☐ The library should be carefully designed to minimize the costs of environmental controls (see section on **The Building Envelope** for additional details).

☐ Reasonable levels of environmental control, designed to protect collections, include:

☐ Relative humidity, perhaps the most important design criteria, should be between 45% and 55% throughout the year, with seasonal fluctuations between the two extremes and daily fluctuations held to ± 3%. This can be achieved only through the design and installation of re-heat coils for dehumidification and clean steam generation for humidification.

☐ Temperature should be between 65° and 75° F throughout the year, allowing seasonal fluctuations between the two extremes, and holding daily fluctuations to ± 5° F. Libraries should avoid the use of "air economizers," which make adequate humidity control impossible.

☐ Controls should be electronic, not pneumatic.

☐ Filtration should minimally be to 50% ASHRAE Dust Spot Efficiency.

☐ Gaseous pollutants such as oxides of nitrogen, sulfur dioxide, and ozone, should be carefully controlled.

☐ Ventilation should be adequate throughout the facility to avoid stagnant air pockets. Libraries should avoid variable air volume (VAV) systems, since such systems cannot adequately filter the air or maintain an adequate air flow throughout the library.

☐ Ideally, these environmental parameters should apply to all collection areas of the facility. If this is not possible, they must minimally be applied to special collections, such as local history and/or microforms.

Fire Protection

☐ All new library construction must ensure fire-safe design by incorporating:

☐ fire-resistent or fire-proof construction,

☐ compartmentalization through the use of fire walls and fire doors,

☐ elimination of all vertical draft conditions or careful installation of fire stops on all floors, and

☐ minimum use of combustible materials in interior finishings and furnishings.

☐ Libraries must also ensure the fire protection of associated buildings, such as parking garages.

☐ Portable fire extinguishers are an important feature of good fire protection. The best all round extinguisher is the multipurpose (A, B, C) dry chemical stored pressure extinguisher. A good size is the 10A:60B:C.

☐ Portable Halon 1211 extinguishers may be used to protect computer systems, expensive equipment, microfilm, and special collections.

☐ Unless required by the local jurisdiction having authority, fire hoses for occupant use should be avoided in favor of optimal fire detection and suppression systems.

☐ Either ionization or photoelectric smoke detectors are appropriate for libraries. Flame and heat detectors, while useful in special circumstances, should be generally avoided.

☐ All libraries must have a signalling system that connects the detectors with either the fire department or a monitoring firm. The exclusive use of local alarms must be avoided since it provides only very limited protection to the institution.

☐ ***The best possible fire control system for libraries is the automatic sprinkler.*** Sprinkler systems must be installed in 100% of all new library construction or renovations. Libraries would be well advised to consider retrofit installation of sprinkler systems in existing buildings. Installations can use either:

> ☐ wet pipe or preaction systems, and
>
> ☐ on-off or cycling sprinkler heads.

☐ While a total flooding Halon 1301 system is appropriate for some special collections, its use should be carefully considered in light of cost, environmental consequences, and degree of protection needed. Typically it is better to provide the entire facility with sprinkler protection than to provide one room with Halon protection.

Designing for Pest Control

☐ Require the removal of all organic material (such as stumps) from the building site. The contractor must not add any organic materials to any fill which might be necessary at the site.

☐ Provide a thorough termite pre-treatment, ensuring compliance with good practice requirements, especially the use of adequate termiticide and correct application.

☐ Avoid all wood-ground contact. All wood forms must be removed or special provisions must be made to ensure they do not serve as a source of termite infestation.

☐ Build pests out, paying particular attention to:

> ☐ the fit of exterior doors,
>
> ☐ use of 20 mesh screen for all openable windows,
>
> ☐ caulking all exterior joints, cracks, crevices, window and door frames, and penetrations,
>
> ☐ screening all air intake vents and weep holes with the smallest screen allowable,
>
> ☐ minimizing eaves and ledges, or alternatively, making them inhospitable for birds,
>
> ☐ sealing all cracks, crevices, and penetrations on interior walls,
>
> ☐ treating interior wall voids with a long-lasting, low toxicity pesticide, such as silica aerogel,
>
> ☐ limiting, correcting, or planning for high moisture areas,
>
> ☐ avoiding the use of plants within the library and carefully controlling their use in landscaping,
>
> ☐ ensuring control of water, channeling it away from the building.

☐ Install HVAC systems to maintain appropriate levels of temperature and humidity, reducing pest populations.

- ☐ Design the library to minimize housekeeping. In particular:
  - ☐ eliminate "dust catchers,"
  - ☐ use rounded corners and joints between floors, walls, and ceilings,
  - ☐ minimize the use of carpet in favor of hard floors,
  - ☐ if carpeting is specified, also specify vacuums capable of adequate cleaning (high efficiency filters, strong motors).
- ☐ Eliminate or control food in the facility.
- ☐ Locate the dumpster or other trash receptacles away from the library.

Library Security

- ☐ Install emergency exits with panic alarms. These should be monitored at some constantly-attended location, such as the circulation desk.
- ☐ Establish a floor plan that allows the staff to keep visual contact with patrons and high use areas.
- ☐ Consider establishing a patron locker area for personal belongings in order to reduce theft opportunities.
- ☐ Ensure that adequate, affordable photocopies are conveniently available. Remember that all copiers must be vented outside.
- ☐ Determine the appropriate level of electronic security within the library, including:
  - ☐ magnetic switches on doors and openable windows,
  - ☐ vibration or shock sensors on glass doors and windows,
  - ☐ motion detectors (ultrasonic, passive infrared, or microwave) within the library,
  - ☐ special detection devices for exhibition areas or cases,
  - ☐ panic buttons and duress signal capability.
- ☐ Use only reputable security firms with a proven record of reliability in your community.
- ☐ All exterior doors, and interior doors to sensitive areas, must have high quality, pick resistent dead bolt locks. Keyways must be proprietary or regionally proprietary. Key blanks must not be available through local locksmiths, hardware stores, or other suppliers. Uncoded room numbers must not be stamped on keys.
- ☐ Landscaping must incorporate security concerns, such as:
  - ☐ avoiding the use of shrubbery around the building, near doors, and by windows,
  - ☐ avoiding the use of landscape features that could be used to vandalize the building or gain entry,
  - ☐ providing adequate lighting around the building and in parking areas
- ☐ Both landscape and interior design must ensure that the staff have clear sight lines to the entrance and building approaches.
- ☐ If a vault is necessary, the library should clearly specify what it is to be used for and what it is intended to protect against.

Book Returns

☐ Book returns for patrons in the library should consist of designated counter or shelf areas, not "drops."

☐ Avoid the use of both book return boxes and book returns attached to the building.

☐ If a book return must be used, an exterior return box is safer than an integral building return.

☐ If an integral building book return is used, take special precautions, including:

☐ isolation of the book return from the rest of the library to prevent the spread of insects and other noxious materials,

☐ installation of fire detection and fire suppression systems, and

☐ installation a floor drain.

☐ In any type of book return drop, minimize the distance the book must fall.

Landscaping

☐ Trees can be appropriate plantings for libraries, but they must be planted where they will not overhang the building when they mature.

☐ Shrubs and organic mulch preferably will not be used immediately adjacent to the structure. If shrubbery is used, it must be non-flowering and low. Mulch must be inorganic, such as river pebbles or pea gravel.

☐ Soaker lines or drip irrigation should be used adjacent to the library, rather than sprinklers. If sprinklers must be used, they must direct water away from the building.

☐ Avoid live plants in the library building.

☐ The site will be graded so that there is a slope away from the library building. In addition, adequate stormwater drains will be installed.

☐ Outdoor spigots must be secured at all times.

☐ Exterior lighting should be just what is essential for security. It must not be located on the library building. Lighting should use high pressure sodium lamps.

☐ Trash dumpsters and lawn maintenance supplies must be placed away from the library building.

☐ Fountains and waterfalls should not be used. If they are used, they must be designed to avoid any possible water damage to collections.

☐ All landscape features, such as bike racks, tables, and benches, should be vandalism proof.

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ABOUT THE AUTHOR

Michael Trinkley is the Director of Chicora Foundation, Inc., a public, non-profit organization that provides library, museum, and archive preservation consulting. Based in Columbia, Chicora has nearly a decade of experience working on a variety of technical preservation issues. Dr. Trinkley received his Ph.D. in anthropology from the University of North Carolina at Chapel Hill. He has conducted many seminars, short courses, and workshops on conservation and preservation issues, including integrated pest management, fire safety, environmental monitoring and control, and building for preservation. Dr. Trinkley has also consulted with institutions throughout the Southeast. He is an associate member of the American Institute for Conservation of Historic and Artistic Works, a member of the Palmetto Archives, Libraries, and Museums Council on Preservation, the American Association of Museums, the Southeastern Museum Conference, and the South Carolina Federation of Museums.