# Section 2

# BUILDING CONSTRUCTION

## 2.1 - RATIONALE

An archival facility should be designed and constructed to preserve its permanent and irreplaceable collections without compromising accessibility or life safety.

Codes and regulations enforced by the project's local Authority Having Jurisdiction (AHJ) are written primarily in consideration of life safety in the event of fires and other emergencies and, to some extent, the protection of property. Less attention is given to protecting the contents of the facility.

Consequently, archival facilities must be designed to achieve a higher level of protection for the collections. Archival facilities must be constructed with durable and non-combustible materials and incorporate structural and fire protection systems that are resistant to failure caused by fire, flood, or other disasters. All major building systems must be designed with long service life expectancies and in a manner that allows for them to be serviced and replaced without significant disruption to the collections storage spaces. If there is a conflict between a code requirement and an archival facility standard, the stricter requirement should govern. It should be noted that there are some codes written especially for collections facilities that are cited within these Guidelines and in the Bibliography.

Many archival collections are housed in facilities that were not designed as archival repositories. Existing structures originally built for other purposes are often unable to support the heavy loads associated with efficient shelving systems and are incapable of achieving the environmental or other protective recommendations without major renovations. In these cases, individual recommendations within this chapter can be used as a guide for mitigating many of the most common deficiencies inherent in non-purpose-built archival facilities. Whether a new building or a renovation to an existing building, consult the standards, codes, and technical criteria for collections repositories.

## 2.2 - GENERAL

### 2.2.1 - Longevity of Construction

Archival collections are permanent and irreplaceable and must be designed with long operating life expectancies for all major systems, including site utilities and the structural, mechanical, electrical, and IT infrastructure systems.

While building systems, such as IT infrastructure and telecommunications, systems, mechanical units, pumps, and other equipment can be expected to have shorter useful lives, the structure of the building, including foundations, walls, roofs, soffits, and window systems, must be designed for the longest service life practicable. The structural systems must be of such quality and workmanship that, except for routine repairs and maintenance, the basic structure will have a useful life of over 100 years.

### 2.2.2 - Quality of Work

As important as the selection of materials and technical details, the care taken in installation contributes to long-lasting use and low maintenance and wear. The project design and the specifications for construction must establish high quality standards for installation of all building systems.

#### 2.2.2.1 - Architect-Engineer Qualifications

Select an Architect/Engineer (A/E) that is familiar with these Guidelines and with successful experience in the programming and design of collection storage, processing, and research facilities for archives, special collections, museums, libraries, and other cultural heritage buildings.

#### 2.2.2.2 - Design Quality Assurance

The A/E team should be required to include an archivist, curator, or preservation specialist who has experience in developing archival and collections repositories.

Additionally, the design process should be organized to include interim design progress reviews during which the Users and consulting preservation specialist can ensure the drawings and specifications meet archival facility guidelines.

### 2.2.2.3 - Construction Quality Assurance and Control

Quality control standards for construction must be developed as part of the planning process and included as part of the project. While good design and well-written specifications lay the groundwork for quality construction, the proper execution of those specifications is critical.

Require that changes/substitutions to the design or construction are reviewed by the A/E team and archival project staff.

An independent Construction Quality Manager (CQM) should be engaged to participate materially in the day-to-day review and assessment of the quality of the work and to provide certification that the project was built in accordance with the design and specification requirements. The CQM should be required to:

- Review and certify all construction installations, including any work that will become hidden or covered by later work.
- Review all tests on completed assemblies such as roofing systems, window glazing systems, sprinkler and fire protection systems, and lighting systems.
- Approve all finishes to ensure that they meet the environmental quality criteria identified in these Guidelines.
- Evaluate all shop drawings and inspect work completed by subcontractors.
- Participate in punch list and routine inspections.
- Oversee commissioning activities for all building systems and components.

The construction contract should require that any items found to not be in compliance must be corrected by the Contractor at no additional cost to the Owner.

### 2.2.3 - Life Cycle Cost Analysis

The long-term sustainability of the building and its operations can be jeopardized by inadequate planning or short-sighted decisions when formulating project budgets, requests for funding, or when attempting to reconcile scope and budget during the design process. In addition to initial capital cost, a Life Cycle Cost Analysis (LCCA) of the long-term operational cost in terms of energy consumption, water consumption, maintenance and periodic replacement of the physical plant should be taken into account.

Through LCCA, it is possible to:

- Assess the cost of acquiring and operating a building throughout its intended life span.

- Provide a comparison of the different construction and operating costs of alternative strategies for implementing any set of solutions.
- Inform the design and investment decisions that are made at an early stage of the construction process.

### 2.2.4 - Sustainability

During initial planning, identify the appropriate measures that support the institution's sustainability objectives. With green building action plans, many collections facilities are reducing their environmental footprint thorough energy efficient design and construction and sustainable operations.

Precise definitions of sustainable construction vary from place to place and are constantly evolving to encompass varying approaches and priorities. The U.S. and Canada have similar definitions on sustainable buildings and their need to be environmentally responsible and resource efficient. [1]

If a particular sustainability goal runs contrary to a collections design standard, priority should be given to adhering to the archival design standards. Designers should identify alternative approaches that will achieve the sustainability project goals without negatively impacting the preservation functions of the project.

### 2.2.5 - Accessibility

Accessibility for archival facilities is critical to the mission of archives and special collections. Consult SAA's accessibility guidelines, the American with Disabilities Act (ADA), and other external accessibility standards for more detailed information.

The Society of American Archivists outlines accessibility criteria for facilities, programs, and communications in its *Guidelines for Accessible Archives for People with Disabilities.* "These *Guidelines* provide basic and extensive recommendations to help archivists provide resources, services, and spaces that are accessible and inclusive."

### 2.2.6 - Operations Readiness

Operations readiness is the process of preparing the operators and supporting organization of a facility under construction for day one operations. For ownership entities having limited experience with the development of archival facilities, it is advisable for the Owner to engage a

[1] https://www.epa.gov/sustainability;
https://www.canada.ca/en/services/environment/conservation/sustainability.html

consultant specializing in Operations Readiness and Assurance (OR&A) to help ensure that, at the point of delivery/handover, they are fully ready to assume ownership and capable of beginning its operation safely and efficiently.

## 2.3 - ENVIRONMENTAL STABILITY

An archival facility should be designed and constructed to promote environmental stability. The enclosure systems should be dense with a high degree of airtightness so that the temperature and RH can be held within the recommended ranges given in Chapter 3 for a minimum of 24 hours. This is an essential passive measure for safeguarding against unusual weather conditions or the failure of environmental control equipment. It will also reduce demand on the HVAC system which in turn will help minimize energy consumption and prolong the service life of the mechanical systems.

### 2.3.1 - Protection from Moisture

Collections should not be placed in spaces experiencing, having a history of, or susceptible to moisture intrusion. The facility should be designed and constructed using building enclosure materials and systems that will prevent damage to documents from exposure to moisture.

Archival materials should never be stored or placed within 6-inches of the floor.

#### 2.3.1.1 - Resistance to Liquid Moisture Intrusion

Exterior walls should be designed and constructed to shed bulk rainwater with an external material assembly and include an underlying membrane that serves as the systems' primary barrier to liquid water intrusion with the controlled diversion and elimination of liquid water that passes beyond the external assembly.

The same is true for areas of the facility that my include decorative or architecturally expressive roof assemblies such standing-seam or flat-seam metal, stone or composite stone shingling, or any other system that is not itself a continuous membrane,

#### 2.3.1.2 - Moisture Vapor Control

Vapor barriers and retarders prevent moisture-laden air from moving into building assemblies where it can condense into liquid water within the structure causing material degradation and the risk of mold growth. Vapor barriers must be installed along the entire exterior of the facility and between any two areas that have different humidity and temperature requirements.

Under-slab vapor barriers are the most inaccessible component of the building enclosure and are highly prone to distress, displacement or damage during construction. Therefore, in addition to being non-permeable, they must also be selected for durability and the highest puncture resistance available.

A non-permeable vapor barrier is required at the perimeter of holding areas wherever calculations indicate a negative vapor pressure between holding areas and other parts of the building.

### 2.3.1.3 - Protection from Water Leaks

Suspended ceiling assemblies should never be installed in spaces beneath roofs nor in collections-containing spaces generally to permit unobstructed visual inspection of floor and/or roof structure above and to facilitate the investigation of leaks.

#### 2.3.1.3.1 - Preventing Exterior Leaks

Water leaks through any part of the building enclosure system can pose a threat to archival collections. The exact location of water leaks is often difficult to determine in modern enclosure systems. Small holes or tears in a membrane allows water to penetrate the system in one location, and then travel a considerable distance until the evidence of the leak is presented on the interior. There are several preventative issues to consider when designing enclosure systems for archival facilities.

- **Equipment Placement**: Equipment should not be placed on the roof. Equipment on roofs can damage the roofing system. In addition, the necessary maintenance activity, including the walking to and from roof equipment locations, stresses the roofing system. If equipment must be placed on the roof, it should not be located over collections-containing spaces.
- **Penetrations**: Penetrations from the exterior should not be made into collections-containing spaces.
- **Skylights**: Skylights and sloped glazing assemblies should not be located over collections-containing spaces.
- **Waterproofing:** A positive waterproofing membrane should be installed on all below grade foundation walls to prevent moisture from entering the facility, to protecting the structural reinforcing within the wall from corroding, and to prevent deterioration of concrete from chemical that are in or that may enter the surrounding site.
    - Adhered sheet membrane systems must be mechanically secured at all terminations to keep them in place if adhesives fail
    - The A/E must be provided with the recommendations of the project's prior geotechnical investigations to determine if a waterproofing system should also be provided below the slabs-on-grade and whether or not a foundation drainage system is needed.

- **Sealant Joints:** Joinery within an enclosure system that utilizes elastomeric sealants should be designed and installed as a *Two-Stage Sealant System* providing a primary and secondary seals in the same joint.
    - The external secondary seals visible from the exterior must be always be vented and weeped to prevent trapping moisture within the joint.
    - Even the highest quality sealant products breakdown over time and fail. The condition of sealant joints must be periodically and comprehensively assessed so that their replacement can be planned and implemented prior failure.

Archival collections should never be stored below grade, but when circumstances dictate the use of basement accommodation, secondary internal shell space should be built so that archival storage spaces are separated from the structural shell of the facility. A continuously traversable perimeter zone should be established between the storage vault and the structure shell of the basement in order to detect, control, and eliminate sources of moisture intrusion. The structural floor slabs of below-grade storage vaults should rest on a continuous layer of drainage bedding that is equipped with a sub-slab drainage system.

Storage in caves has precedence and, while cave storage sites may be an innovative option for records centers and other facilities that store temporary and/or inactive records, it is not recommended for archival storage. In circumstances when administrative authority requests consideration of cave storage, it is critical that the facility planning adhere to as many of the Guideline in this document as possible and demonstrate long-term low risk to collections because of water, fire or geological/seismic hazards.

#### 2.3.1.3.2 - Preventing Interior Leaks and Flooding

Intermediate floors in multi-story facilities should be waterproofed to prevent the migration of water through the floors, their transitions to the base of surrounding walls, corners, and at the juncture of different construction materials. Curbs or sleeves shall extend 6-inches above floor level to divert water away from through-floor penetrations or other necessary horizontal openings (fire dampers and other firestopping assemblies may not be adequate to resist water leaks).

Stormwater drainage systems should be designed to include provision for sufficient weir overflows to prevent water from backing up or failing to drain when an outlet is blocked.

With the exception of fire sprinkler piping, collections-containing spaces should not be built with water-containing infrastructure running through them. When this cannot be avoided, protection from leaks should be provided by containment piping systems or, as a minimum

recommendation, drain pans should be provided along with water sensors to alert facility managers.

#### 2.3.1.3.3 - Removal of Discharged Fire Water

Provision should be made for the controlled and rapid drainage of water that can accumulate from the discharge of fire sprinklers or firefighting operations. Drains should be equipped with insect screens or insect-proof cores and carefully located to be effective while not interfering with archival operations. Drains should be periodically monitored to check that that they are unobstructed and functional.

Appropriately sized pumping systems that remove water should be considered as a supplemental precaution or as an alternative to a gravity drainage system for collections-containing spaces. If provided, this pumping system must be connected to an emergency power system so that if normal power is lost the pumps will continue to operate.

### 2.3.2 - Protection From Light

The duration, spectral range, and intensity of illumination in an archival facility must be controlled to minimize exposure to light. The damage from exposure to light is cumulative and can cause inks, pigments and dyes to fade, and result in the degradation of the media.

#### 2.3.2.1 - Protection From Natural Light

The facility should be designed to prevent the entry of direct sunlight into collection-containing spaces. When renovating existing buildings where windows are present, window units should be replaced with UV-protected glazing assemblies, or they should be equipped with a UV filter.

Similar measures should be taken for collections-containing spaces such as processing rooms and reading rooms where windows may be desired to provide daylight and views for occupant comfort and wellness. In addition, shutters, blinds, or shades should be used wherever practicable.

#### 2.3.2.2 - Protection From Artificial Light

Lighting should not emit UV radiation of wavelengths less than 400 nm. For circumstances when collections are to be placed in existing facilities having lighting systems that do not meet this requirement, they should be equipped with a UV filter that effectively blocks any light having a wavelength of 400 nm or less.

#### 2.3.2.2.1 - Selection of Lighting Fixtures

Select lighting technology for collection storage spaces based on the following:

- energy efficiency
- fire risk
- heat output and impact on cooling demand
- reflectance of interior finishes; use of light-colored surfaces on floors, walls and ceilings can improve the distribution of light to maximize ambient light levels with less intense lighting sources.

Lighting fixture housings should not obstruct access to the shelves and there should be a minimum distance of 18-inches between a fixture and the nearest unprotected document.

#### 2.3.2.2.2 - Layout of Lighting Fixtures

Lighting should be arranged along the length of each aisle and cross-aisle so that aisles, when in use by staff, are not left in shadow. Lighting may be attached to the shelving system or integrated into the mobile shelving system.

Lighting fixture housings should not obstruct access to the shelves and there should be a minimum distance of 18-inches between a fixture and the nearest unprotected document.

#### 2.3.2.2.3 - Illuminance of Collections Storage Spaces

The lighting design for collections storage spaces must take into account the health and safety of archival staff. Lighting conditions should not be uncomfortably dim or excessively bright with the ideal illuminance between 10fc and 30fc. The brightness is of less concern if the materials are boxed, but energy usage and temperature control need to be considered.

Emergency lighting system conforming to the requirements of the life safety codes must also be provided. Additionally, a separate lighting circuit for cleaning and maintenance can be useful to further limit the use of lighting within the storage spaces.

#### 2.3.2.2.4 - Lighting Circuits and Control

To minimize exposure to light and maximize energy efficiency, lighting should be switched off either manually or automatically when not required and large storage spaces should be divided into separate lighting zones.

Switches should ideally be placed outside the repository to enable their isolation for service and maintenance purposes.

For compact mobile storage systems, consider available options for switching lighting on and off as individual aisles are opened and closed.

### 2.3.3 - Reducing Air Infiltration

Air leakage through the building enclosure can significantly impact heating and cooling loads, and airtight construction is more important for high performance buildings like archival storage facilities than for conventional buildings. The components of the building enclosure that influence airtightness are collectively referred to as the *Air Barrier System/Assembly*, which consists of air barrier materials integrated together with supporting substrates to resist the air pressure differential caused by wind, stack effect, or mechanical pressurization of a building.

The air leakage rate of the air barrier assembly should be limited to a maximum of 0.01 cfm/sf at 0.3 in. water (0.1 L/s·$m^2$ at 75 Pa). However, in light of the wide range of available systems, details and transitions common to the overall enclosure system of any particular building, it is more important to consider the rate of air leakage for the entire building where the overall quantity of air leakage is the main concern. Consistent with the criteria given in the 2009 ASHRAE Handbook of Fundamentals, Chapter 16 (Ventilation and Infiltration) for "tight" buildings, this document recommends an interior/exterior pressure differential of 0.1 cfm/sf at 0.3 in. water (0.5 L/s·$m^2$ at 75 Pa) for whole building performance.

It is also important to include requirements for field testing the air leakage of the whole building to demonstrate that the airtightness criteria have been achieved. The most commonly cited method for this type of testing is ASTM E779 *Standard Test Method for Determining Air Leakage Rate by Fan Pressurization.*

### 2.3.4 - Maintaining Different Interior Environmental Conditions

Spaces within the interior of the facility used for holding, processing, and display of artifacts or archival material with specific temperature and humidity requirements must be separated from other parts of the building by a non-permeable air barrier.

Openings such as doorways and penetrations associate with building system distribution infrastructure like ducts, sprinkler piping, and electrical or communication conduits must be sealed to limit the flow of air in and out of the room.

Vestibules must be considered as a means to stabilize the environment in critical areas such as

holdings storage and processing rooms. The processing rooms can often serve as an effective vestibule to buffer archives storage spaces.

### 2.3.5 - Building Acclimatization

In new construction, including major renovations, allow time in the project schedule for collections-containing spaces to dry out and for the monitoring of interior environments to confirm that stable conditions have been achieved. This acclimatization requirement should not be relaxed or omitted due to construction delays and should be incorporated into the project schedule during the preplanning process.

Archival materials should not be moved into new spaces until the designed conditions have been achieved and their stability has been proven through sustained monitoring referred to as *trending*.

### 2.3.6 - Commissioning

*Commissioning* (Cx) provides documented confirmation that the building systems function according to design criteria and perform interactively according to the design intent and the owner's operational needs. In the case of existing buildings with existing systems, the procedure is referred to as Retro-commissioning, but the objective is the same: to optimize the performance of all building systems in accordance to their original design and the owner's operational needs.

*Enhanced Commissioning* refers to this same process when there is the appointment of an independent Commissioning Authority (CxA) and includes additional commissioning services before and after the construction phase of the project. With enhanced commissioning, the CxA is engaged early in the project to review and comment upon the developing design and construction documents. At the completion of the project, the CxA also performs verification of end user training and verifies the continued performance of systems 10 months after completion.

*Building Enclosure Commissioning* (BECx) is a similar process that ensures the facility's enclosure systems meet the required performance objectives. Specifically, the BECx process ensures enclosure systems are properly detailed and specified, that they are properly installed on-site, and that they meet the specified performance criteria post-installation.

Archival facilities are high-performance buildings and should justifiably require both enhanced commissioning and building enclosure commissioning using certified independent commissioning agents.

### 2.3.7 - Dust Prevention

All exposed surfaces should be sealed to prevent the abrasion, disturbance or release of particulates that can form dust. All exposed concrete should be sealed with a low volatile organic compound acrylic membrane curing compound. Floors should be topped with an epoxy coating and wall should be painted.

### 2.3.8 - Mold Control

Appropriate temperature and humidity levels are essential in all archival facilities, and there should be systems in place for measuring and responding to elevated temperature and humidity levels. Mechanical dehumidification systems must be provided in underground storage environments. Mold growth can be a significant problem in these environments and must be carefully considered when selecting mechanical systems.

Given the hazard mold growth poses for both collections and staff health, an action plan should be developed and practiced so that facility managers are prepared to respond to mechanical system failure.

## 2.4 - BUILDING ELEMENTS

### 2.4.1 - Structure

The building foundations, exterior, and load bearing walls, floors, columns, windows, and roof decking should all be designed with a high level of durability and longevity. Use building materials having the lowest level of volatile organic compounds (VOC's) available, especially those materials used to construct collections storage spaces. See Appendix 1 for a list of restricted materials.

#### 2.4.1.1 - Building Framing

The structural frame of an archival facilities must be constructed with non-combustible materials and should be as fire resistant as possible. Type 1 construction is recommended, ideally of cast-in-place concrete, to provide the following levels of fire resistance:

- Structural Frame: 3 hours
- Floor/Ceiling Assembly: 2 hours
- Roof Protection: 1½ hours

In cases where structural steel is utilized as part of Type 1 construction instead of cast-in-place concrete, it should be fireproofed with high density Spray-Applied Fire Resistive Materials (SFRM) having the following properties:

**Table 1 - Minimum SFRM Requirements**

| | |
|---|---|
| Density | The greater of 40 lbs/ft$^3$ or the density required to attain the required fire-resistance rating [1] (ASTM E-605) |
| Thickness | 3/8" minimum (ASTM E-605) |
| Bond strength | 10,000 psf minimum [1] (ASTM E-736) |
| Compressive strength | 550 psi [1] (ASTM E-761) |

[1] Where the structural elements are concealed by other construction and not susceptible to disturbance by maintenance personnel, then the following reduced SFRM characteristics are permissible:

- Density: 22 lbs/ft$^3$
- Bond Strength: 2,000 psf
- Compressive strength: 100 psi

This degree of density and hardness can be greater than what may be needed to achieve the required degree of fire resistance but is important for two reasons. The first is to minimize the likelihood of the material being abraded due to maintenance, repair or operational activities that could result in air born particulates entering the interior environment, and the second is to minimize the potential for significant damage to or disturbance of the material that could result in reduced fire resistance.

### 2.4.1.2 - Minimum Recommended Floor Loading

The table below is provided as a supplement to the minimum structural requirements governed by the IBC, ASCE and local regulations.

**Table 2 - Recommended Minimum Floor Loading**

| **Space Type** | **Floor Load lbs/sq. ft** |
|---|---|
| Offices, conference rooms, research rooms | 100 |
| Processing rooms | 200 |
| Corridors: non-collections movement | 100 |
| Corridors: collections movement | 250 |
| Stairs and lobbies | 100 |
| Galleries for permanent or temporary exhibits | 250 |
| Exhibit support spaces | 150 |
| Loading dock and receiving rooms | 250 |
| Collections storage | 350 [1, 2, 3] |
| Mechanical/electrical equipment rooms | 150 [4] |
| Door thresholds, inclines and elevator sills | Equal to the space served |

[1] Floor deflection must be limited to L/750 when compact shelving is used.

[2] Proposed system must be reviewed to confirm adequacy of line load and rail deflection requirements.

[3] Based on conventional floor-to-floor height. High-bay applications must be considered on a case-by-case basis and commonly require a Class 9 superflat floor surface as defined in the ACI 302.1R, *Guide to Concrete Floor and Slab Construction* in order to achieve the surface tolerances required by high density shelving equipment suppliers.

#### 2.4.1.2.1 - Existing Facilities

In an existing building, the floor load limits must be established by a licensed structural engineer. These limits must take into consideration the configuration of the space, width of the aisles and cross-aisles, weight of the specific type(s) of collections being stored, height and type of shelving and/or storage equipment and the resulting concentrated loads on the floor. The allowable load limit must be posted in a conspicuous place and must not be exceeded.

Where the use of mobile shelving is being considered, an assessment regarding its suitability should be made by a structural engineer in conjunction with the shelving manufacturer.

### 2.4.1.3 - Seismic Resistance

An archival facility must be designed to provide a high level of protection for the structural, nonstructural, and major operating equipment in the event of an earthquake or other seismic event. Even in areas of low seismicity, the A/E should consider all principles of seismic resistant design since many of these features add safety from other threats to the facility.

In addition to the minimum seismic design requirements governed by the building codes to provide for life safety, meaning that the building may collapse eventually but not during the earthquake, an archival facility should be designed and constructed to achieve better post-seismic event performance to minimize all damage and to ensure that archival storage environments can be maintained. This includes:

- All nonstructural elements, components, and equipment located within the building, including all storage equipment, must be anchored.
    - Mobile storage units must be designed and installed to sustain the same loads as the main structure itself.

  - Shelf guards and/or other restraining measures must be installed on all collections storage shelving units and exhibit cases.
- Lighting fixtures and HVAC devices installed in suspended ceilings must be independently supported.
- Mechanical, electrical, plumbing, and communications infrastructure equipment must be anchored to prevent overturning or sliding.

### 2.4.2 - Building Enclosure

The building enclosure, sometimes also referred to as the building *envelope*, includes all materials, components, systems, and assemblies intended to provide shelter and environmental separation between the interior and exterior. The building enclosure must be humidity tolerant, allowing the relative humidity standards to be maintained without damage to the structure.

#### 2.4.2.1 - Exterior Walls

Exterior walls must be of durable and fire-resistant products like masonry having a high thermal and hygroscopic capacity. Joints in and between building enclosure systems must be provided with appropriate flashing and properly designed and executed sealant joints.

It is advisable to avoid placing storage equipment against exterior walls so that, if problems are discovered or develop with the performance of the building enclosure system, inspections can be performed, and remediation efforts can be implemented without necessarily having to relocate collections. A minimum 18-inches of standoff is recommended between storage equipment and the interior face of the building enclosure system.

#### 2.4.2.2 - Building Insulation

The energy consumed to maintain appropriate environmental conditions for archival storage drives one of the most significant operating costs for an archival facility. In conjunction with airtight construction and the proper placement of vapor barriers/retarders, insulating the building for thermal resistance can dramatically reduce energy consumption. For this reason, energy codes, sustainability certification programs, and criteria developed by governmental entities that own and operate archival facilities are requiring stricter energy performance requirements.

An archival facility should be designed to achieve at least a 30% reduction in energy consumption than what is indicated in the current ASHRAE 90.1. The Architect/Engineer should be required to demonstrate the design can achieve the recommended level of energy performance by subjecting the proposed design to computerized energy modeling.

**Table 3- Recommended Minimum Thermal Insulation Values**

| | |
|---|---|
| Roofs | R-30 |
| Exterior Walls | R-19 [1] |
| Window Walls | R-5 [2, 3] |

[1] Refers to the overall thermal resistance of the exterior wall when considering both opaque walls and window openings.

[2] The window-to-wall ratio (WWR) should be kept to a practicable minimum to help achieve higher overall exterior wall performance.

[3] Window wall systems should leverage thermally resistive characteristics such as argon-filled glazing units in thermally-broken frames with non-conductive glazing spacers.

Formaldehyde-based insulation and foamed-in-place insulation must be avoided throughout the library and not used in holdings storage rooms, processing rooms, or exhibit galleries.

### 2.4.2.3 - Entrances and Door Openings

Building entrances for both public and staff must include a vestibule or a revolving door to control infiltration. Secondary exterior doors such as fire exits securely seal when closed to prevent infiltration of air, dust, and pests.

Doors from all collections-containing spaces must have airtight and fire rated weather stripping. Gaps between doors and their frames shall be kept to a practicable minimum and protected on the top and sides by gasket type weather-stripping. The bottom of all doors must be fitted with brush-style synthetic fiber weather-stripping.

### 2.4.2.4 - Other Exterior Openings

Exterior openings into the building and penetrations of utility systems should be sealed to prevent animals such as birds, bats, vermin, and insects from entering the building. Louvered openings for ventilation or exhaust should be fitted with layers of screening durable enough to resist birds and fine enough to resist insects.

Special attention should be given to exterior foundation gaps, exterior roll doors, loading dock areas, attic windows, aerators, and floor drains. See sections 2.5.7 and 7.3. Doors should be installed and sealed tightly in their frames and equipped with applied door sweeps or equivalent hardware that will resist insects when the doors are in their closed positions.

A 24-inch-wide inspection zone free of vegetation should be maintained around the entire perimeter of the building to facilitate periodic visual inspection of the exterior enclosure and its openings.

### 2.4.2.5 - Roofs

The roofs of archival facilities must be constructed of durable, long-lasting, and non-combustible materials.

- The roofing membrane and flashing should be designed to be easily accessible for replacement during the life of the building.
- Roofs over all collections storage spaces must be designed with a minimum ½ inch per foot slope. Elsewhere, the minimum roof slope shall be ¼ inch per foot.
- Low points of roof drainage must not be located over collections-containing spaces and all roof drains must be located at the low points.
- All roofs must be provided with a separate overflow drainage system.
- Roof drains provided to remove stormwater and snow melt should be designed and sized for the uncommon weather events. Planners should design drains to 125% of the international plumbing code criteria and should use – at a minimum – a 100-year event parameter.
- Consideration should be given to providing electrically heated drains in localities where the accumulation and melting of snow on low-slope roofs may freeze and obstruct drainage.

#### 2.4.2.5.1 - Green Roofs

The term *Green Roof* is a common term for what is also known as a *Vegetative Roofing System*, which consists of a waterproof membrane, root repellent system, drainage system, filter cloth, a lightweight growing medium, and plants. Green roof systems may be modular, with drainage layers, filter cloth, growing media, and plants already prepared in movable, often interlocking grids, or loose laid/built-up whereby each component of the system is installed separately.

Generally, archival facilities should not have green roofs, or at a minimum should not have green roofs located directly above collections-containing spaces because, despite their many benefits (enhanced stormwater management, moderation of urban heat island effect, and improved air quality), they can also sustain a wide variety of insects and, if not properly maintained, can even pose increased fire risk.

However, local stormwater management regulations and/or the project's sustainability objectives may require or necessitate a green roof on all or a portion of the facility. In these instances, a modular green roof assembly should be used to permit for inspection and repair of the roof.

Additionally, it is imperative that the green roof be well maintained to sustain the system by keeping vegetative roof plants healthy and to keep dry foliage to a minimum; such maintenance includes, but is not limited to irrigation, fertilization, weeding. Excess biomass such as overgrown vegetation, leaves and other dead and decaying material shall be removed at regular intervals not less than two times per year. Provision shall be made to provide access to water for permanent or temporary irrigation.

### 2.4.3 - Interior Construction

Interior construction should be easy to maintain and constructed of durable, fire-resistant products. Construction materials used in partitions, ceilings, and floors must be rated as Class 2 (flame-spread rating of 25 or less) as tested according to the ASTM E-84 and must have a smoke development rating below 450.

#### 2.4.3.1 - Doors, Doorways, and Passageways

Doors shall be mounted within steel frames, have a solid core, and be either wood or steel.

The doorways and passageways in the building must be sized to meet ADA requirements for accessibility and to meet the requirements for movement of people and materials between spaces. In addition, the following spaces require larger openings:

- The receiving room must have a doorway at least 8 feet wide and 10 feet high to the loading dock. A combination of a personnel door and an overhead coiling door is recommended.
- Doors from all collections-containing spaces to any corridors or adjoining processing rooms or other support spaces must be double width, at least six feet wide with two 3-foot leaves. An additional door at least three feet wide may also be provided for use by staff without records.
- In facilities with exhibit galleries for permanent or temporary exhibitions, doors to collections storage spaces that will house artifacts/objects, exhibit production and staging/support spaces, and temporary exhibit galleries must be a minimum of 6 feet wide and 10 feet high.
- All doorways and passageways between the loading dock and equipment rooms for mechanical, electrical, plumbing, and communications infrastructure equipment must be sized to permit equipment entry on pallets without tilting.

- Door widths for pantries and lounges must be sufficient to allow for the movement of vending machines into and out of the room [3’-2” minimum].
- Service corridors must be at least 8 feet wide. Corridors along the artifact/object movement path between the receiving room, exhibit galleries, and all other artifact/object-containing spaces must be 8 feet wide and have an unobstructed vertical clearance of 10 feet to the bottom of all ceilings, soffits, lighting fixtures, exit signs or other ceiling-mounted devices.

#### 2.4.3.2 - Floor Surface Conditions

Floor surfaces should be designed, detailed, and constructed so that they are level and uninterrupted by steps, door sills, HVAC grilles or mats to allow for the easy passage of carts. Additionally:

- Transitions between different floor finish materials and assemblies should be detailed such that there is zero change in level at the juncture of the differing finishes.
- Differing thicknesses of floor finish assemblies should be accommodated by constructing coordinated depressions in the underlying structural substrates to coordinate with the corresponding floor finish assemblies.
- Control joints in concrete slabs should be filled full-depth with epoxy to prevent surface fractures caused by rolling loads.
- Joint cover systems for movement joints must be selected for compatibility with rolling loads and should be carefully detailed and installed to ensure they will perform as intended.

Where a change in floor level is unavoidable, ramps with a maximum slope of 8% should be provided.

#### 2.4.3.3 - Compartmentalization

Depending on the volume of archival storage in a facility and other measures of the overall fire prevention strategy, the compartmentalization of the storage spaces may not always be advisable as they can also hinder efficient use of the space and complicate logistics.

When utilized, compartmentalization can provide a passive system of fire safety and/or environmental control, and the surrounding walls, floors, ceilings, and doors of each compartment should be constructed such that fire, smoke and water will not spread into adjacent compartments. The recommended maximum quantity of holdings stored in a single fire compartment is 125,000 cubic feet.

## 2.5 - OTHER PLANNING CONSIDERAIONS

### 2.5.1 - Collections-Containing Spaces

Planning considerations for collections-containing spaces are primarily addressed in Chapter 9 of this document with additional guidance pertaining their design and construction provided throughout many of the other sections of this chapter.

### 2.5.2 - Utility Spaces

#### 2.5.2.1 - Access and Maintenance

Proper maintenance is a key factor in prolonging the useful life of a building and reliably maintaining the interior environmental conditions that are crucial to the preservation of archival collections. Sufficient service access for maintenance, repair and replacement must be provided for all the building's systems, including mechanical, plumbing, electrical, fire protection, and security. Buildings should be designed so that its components are accessible without entering archival storage spaces except for those specifically located within the archival space (lighting, fire and smoke alarm components, sprinkler piping and heads, etc.).

#### 2.5.2.2 - Mechanical Systems

The mechanical systems for an archival facility should be designed so that the environmental criteria are achieved and not compromised at any time.

- In larger facilities, storage vaults and other critical areas should be served from a separate, dedicated HVAC system (s) than those serving the rest of the facility.
- Storage vaults, processing areas, and exhibits must be isolated from sources of pollutants, such as the loading dock, machine rooms, or spaces where cooking, painting, exhibit production, and other such activities take place.
- The entire building should be under positive air pressure. In particular, storage vaults must be kept under positive air pressure.
- Areas such as the loading dock, food preparation areas, and exhibit production areas should be kept under negative pressure in relation to adjacent spaces.
- The building envelope should be airtight with the intake of outside air controlled through the mechanical system.

#### 2.5.2.2.1 - Placement of Equipment Rooms

Mechanical Equipment Rooms (MERs) and water piping should not be located above or adjacent to collections-containing spaces. Leaks in mechanical spaces are common, and even with optimum waterproofing, liquids can enter adjacent areas. If a mechanical room must be located above a collections-containing space, then additional water proofing measures must be installed, up to and including measures that are tantamount to a roofing system with appropriate drains under the mechanical room that removes any water that leaks through the mechanical room floor. Install water sensors in storage vaults to detect leaks that might originate from the roof, mechanical spaces or bathrooms. Ideally, water sensors should also be installed in mechanical spaces for early leak detection.

When mechanical rooms are located adjacent to collections-containing spaces, special precautions should be taken to guard against water infiltration through walls. Walls should be constructed on or beside containment curbs and waterproofed. Additional floor drains should be installed to rapidly remove any accumulation of water within the mechanical spaces. In addition, depending on the type of mechanical room, vapor barriers in the walls may also be necessary to maintain appropriate environmental conditions in adjacent archival storage areas.

#### 2.5.2.2.2 - Outside Air Intakes

Outside air intakes should ideally be at the uppermost roof level and should be located to ensure that pollutants do not enter the building air supply. At a minimum, they must be at least ten feet above grade level. In addition to gaseous pollutants from vehicles and industries, designers should be aware that significant pollution from fertilizers, insecticides, and dust can occur from farm or landscaping activities.

#### 2.5.2.2.3 - Piping

With the exception of piping for fire protection sprinklers directly serving collections-containing spaces, no water-containing supply, return or drainage piping infrastructure of any nature should be routed through collections-containing spaces, especially storage vaults.

#### 2.5.2.2.4 - Equipment Redundancy

HVAC system redundancy should be provided for archival storage spaces. This can be accomplished through cross-feeding from chillers, installing additional ducting and dampers, allowing air to be circulated from multiple air handlers, or a combination of all these measures. In all cases, spare parts should be stocked on-site to permit more rapid repairs in the event of equipment failure.

#### 2.5.2.3 - Electrical Systems

The design of all electrical systems (standard and emergency power) should provide distribution capacity that exceeds the loading criteria mandated by code. Electrical substations must be loaded to no more than 65% of their rating.

Spare conduits and breakers (or space in panels for future breakers to accommodate new or diversified loads) should be provided to accommodate for future growth and/or changes. When provided, spare conduits should include junctions with pull strings to support future connections.

Consideration should be given to reserving additional wall and floor space for the future accommodation of temporary equipment to facilitate the uninterrupted replacement of the electrical system over time.

##### 2.5.2.3.1 - Emergency Power Generator

A generator for *emergency power* (for systems essential to life safety), *legally required standby power* (for firefighting, rescue operations and control of health hazards) and *optional standby power* (for protection of property) loads should be supplied for archival facilities and must be located at least 100 feet from communications equipment to avoid radio frequency interference.

Optional standby power should be provided for the following:

- Telephone switch and telephone system
- Security system
- Power and lighting for security control center
- Mechanical control systems
- Building automation and environmental management systems
- Sump pumps
- Sewage ejector pumps
- Cooling systems for computer and UPS rooms
- Exhaust fan in UPS battery rooms
- Mobile shelving

Natural gas is preferred for the fuel supply. However, the supply must not be interruptible. Otherwise, the design must provide for a diesel fuel supply for the backup generator with at least 48 hours of fuel capacity.

#### 2.5.2.4 - Communication Systems

Archival facilities should be designed and constructed so they can be equipped with the latest available and supported technologies for the full range of communication systems and should comply with the most current version of the Commercial Building Wiring Standards and Building Infrastructure Standards.

The A/E design team shall include an Information Technology (IT) consultant with a current BICSI certified Registered Communications Distribution Designer (RCDD) with a working knowledge of standards, guidelines and recommendations related to Structured Wiring Systems and their component parts that have been established by BICSI Standard, EIA, TIA and ANSI.

In addition to the customary telecommunication and data systems, newer communication systems in widespread use should also be included, such as:

- Network wireless access to the public and staff via multi-channel wireless access points (WAP).
- Neutral Host In- Building Multi-band Cellular Distributed Antenna System (DAS) in order to provide cellular voice and data coverage inside the facility.

Technology will continue to change the requirements for new connections and equipment. Therefore, communication systems and the other building systems that support communication system infrastructure should be designed for 50% above the requirement for initial occupancy to allow for future connections to routers, phone switches, and other communication equipment at a later date.

### 2.5.3 - Water Features

Water features, pools and fountains within archival facilities should be avoided. When circumstances dictate their placement near or adjacent to archival facilities, additional protection against water intrusion should be considered for the facility.

### 2.5.4 - Building Underground

Placement of an archival facility underground should be avoided. In addition to the increased risks of water leaks and flooding addressed in the *Protection from Moisture* section above, there are multiple other challenges to building and operating underground facilities, including:

- Greater potential for both the temporary and ongoing pumping of groundwater.

- Increased likelihood that stormwater and sanitary sewerage systems will not be able to drain from the facility by gravity, necessitating the added costs, complexity, and standby electrical power for multiple pumping systems that include piping under pressure.
- Requirements for smoke compartmentalization and mechanically assisted smoke extraction systems.
- Radon Gas: Depending on the geological conditions of the project site, the presence of radon gas can pose significant health hazards and threaten the preservation of collections in below-grade or underground facilities. Testing for the presence of radon gas must be performed, and proven mitigation measures such as dilution ventilation installed to ensure that the gas does not accumulate in these facilities.

### 2.5.5 - Natural Hazards Mitigation

Archival facilities should be designed to adopt strategies that exceed model building code requirements for disaster resistance in order to mitigate against natural hazards. Codes define minimum requirements for life safety and serviceability, and compliance with codes does not guarantee that a facility will be able to withstand and recover rapidly from disruptions caused by natural disaster nor does it ensure the continuity of archival operations.

Mitigation protects against the cascading effect of damage caused by an initial disaster that is amplified by additional new hazards generated by first event, thus further increasing the rate and magnitude of loss. These unanticipated interactions from concurrent or sequential multi-hazard events (dependent or independent; natural, man-made or accidental) result in a compounded impact and previously unconsidered consequences.

Proactively integrating mitigation measures into new construction will reduce the impact of natural hazards, the cost of the disasters they cause, and is typically more economically feasible than retrofitting existing structures.