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Instructions

The Yale University Design Standards establish the requirements for designing and building new structures and for remodeling existing structures at Yale University. The standards are also intended to assist design engineers in maintaining both consistency on a particular project and continuity with existing Yale University systems and equipment. Architectural and engineering firms and Yale University staff must use these standards as the basis for developing all facility design and construction documents.

Review the relevant sections and references listed in each section of the standards, and comply with all applicable design requirements. Comply with applicable Federal and State codes, the Design Standards Handbook, ASHRAE Guidebooks, OSHA regulations, and applicable NFPA requirements. When applicable codes and regulations are at variance with these standards, comply with the more stringent requirements.

Ensure that all drawings and specifications are in compliance with the Connecticut Basic Building Code, applicable zoning laws, environmental regulations, and other governmental regulations and statutes governing the design, construction, and use of new or remodeled Yale University facilities. Use the current edition of the Guide to Building Design & Construction Regulations in Connecticut as a reference. This publication may be obtained through the office of the Connecticut Society of Architects or through the American Institute of Architects.

The Yale University Project Manager is responsible for ensuring that design and construction professionals adhere to these standards. Refer questions and comments regarding the content and use of these standards to the Yale University Project Manager. Submit proposed deviations to these standards, in writing, to the Project Manager for approval, before incorporating the proposed changes into the design and construction documentation. Yale University periodically revises and updates these standards as technology changes and as codes, regulations, and legal mandates are revised or instituted. Use the Design Standards Change Proposal to suggest changes, additions, or deletions to these standards. Submit the proposal form to the Yale University Facilities Development Office. See the Yale University website for the appropriate department.
Because each section of these design standards includes cross-references to applicable industry standards, codes, regulations, and guidelines, as well as to other sections within these standards containing relevant design criteria, architects and engineers doing work for Yale University are expected to maintain a compete and current edition of these standards. For ease of reference, the numbering of the various sections and their organization by division correspond to the current Construction Specification Institute MasterFormat™ structure. However, these design standards are not intended for use, in whole or in part, as specifications. Do not copy design criteria verbatim in specifications or in notes on drawings.
Information Available to Designers

This document provides design standards only, and is not intended for use, in whole or in part, as a specification. Do not copy this information verbatim in specifications or in notes on drawings. Refer questions and comments regarding the content and use of this document to the Yale University Project Manager.

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B. Capital Projects Handbook
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A. Summary
This section identifies and describes campus planning documents, the project program, and the various groups at Yale University with responsibility for facilities design and engineering. In addition, this section contains general interior and exterior space requirements.

B. Capital Projects Handbook
Yale University developed the Capital Projects Handbook to document and communicate the work processes and other important information needed to effectively complete capital projects at Yale University.

C. Campus Planning Documents
Campus planning documents include the Campus Plan, the Science Hill Plan, the Undergraduate Residential Facilities Plan, the Arts Area Plan, and the Yale Medical School Plan.

1. Campus Plan
Yale University has developed an approach to the long-term stewardship of the campus called the Framework for Campus Planning, dated March 2000 and prepared by Cooper, Robertson & Partners. The plan consists of two documents—the Framework Plan and the Manual that provide design professionals with the proper context for campus building and renovation projects.
2. **The Framework Plan**
   The Framework Plan is a general and public document that contains recommendations for: (a) the seven University planning precincts, (b) future development sites and open space for each precinct, and (c) campus systems, such as use, building form, landscape and open space, vehicular and pedestrian circulation, parking, signs, lighting, and neighborhood interfaces.

3. **The Manual**
   The manual is a specific and internal document containing development guidelines for the opportunity sites within each planning precinct and for campus systems. These development guidelines are the parameters for the building design including planning context, general character, use, density, building form, height, access, parking or service, and landscape areas.

4. **Science Hill Plan**
   The Science Hill Plan, dated February 2000 and prepared by the Hillier Group, describes: (a) the future programmatic distribution for each of the five departments on Science Hill, (b) the future disposition of the buildings on Science Hill, (c) those buildings that will be remodeled or demolished, and (d) the locations of new buildings, and (e) the relationships of new buildings to existing buildings.

5. **Undergraduate Residential Facilities Plan**
   The Undergraduate Residential Facilities Plan, dated July 1995 and prepared by Herbert S. Newman and Partners, examines the physical and programmatic needs of 25 buildings (12 of which are residential colleges) used as living quarters and for social and recreational activities for undergraduate students at the University.

6. **Arts Area Plan**
   The Arts Area Plan, dated December 1995 and prepared by Polshek and Partners, describes the physical conditions of the existing buildings in the arts area; parking, traffic, and utility conditions; potential expansion sites; reallocation of existing space; and construction of new buildings.

7. **Yale Medical School Plan**
   To be developed.
D. Project Program and Project Site

Unless otherwise stated, Yale University will prepare a project program. The project program includes a program narrative, mission statements, information about occupants, relationships between spaces, area requirements, environmental requirements, and space finishes and fittings. The project site is described in the project program or request for proposal.

E. Interior Space Standards

The following interior space standards include general space descriptions and requirements.

1. Public Contact Spaces

   Public contact spaces are those where building occupants meet the public. They include reception areas, display areas, exhibit spaces, galleries, and customer service desks.

2. Occupant Work Spaces

   Occupant work spaces are intended primarily for one occupant. They include offices and open office cubicles.

3. Equipment Utilization Spaces

   Equipment utilization spaces are those where more than one person may use common equipment. They include copier rooms, work rooms, computer rooms, and mail rooms.

4. Assembly Spaces

   Assembly spaces are those without fixed seating. They include assembly halls, dining halls, library reading rooms, and multipurpose rooms.

5. Meeting and Instruction Spaces

   Meeting and instruction spaces include meeting rooms, conference rooms, classrooms, laboratories, and learning laboratories.
6. **Food Preparation and Serving Facilities**
   a. Locate and design food preparation and serving facilities to:
      - Enable efficient operations
      - Minimize contamination and spoilage of foods
      - Enable easy maintenance and cleaning
      - Provide effective protection against the entrance and harborage of pests
   b. Provide a facility that is flexible enough to accommodate periodic changes and adjustments due to changes in production procedures.
   c. Base the design on the recommendations of an experienced food service consultant.

7. **Occupant Services Spaces**
   Occupant services spaces include toilets, showers, rest areas (lounges), and sleeping quarters.

8. **Storage Spaces**
   Storage rooms are those used for storage. They include closets, storage rooms, cold storage rooms, specially-conditioned storage spaces, secure storage spaces, and animal housing.

9. **Circulation Spaces**
   Circulation spaces include corridors, lobbies, waiting areas, vestibules, stairs, ramps, and elevators.

10. **Building Services Spaces**
    Building services spaces include maintenance shops, loading docks and those used for service sinks, maintenance equipment, trash collection, and trash removal.

   a. At least one janitor’s closet is required on each floor of each wing (if applicable). Janitor's closets must be accessible from a public corridor and contain a slop sink and storage for custodial equipment, such as mops and buckets, water vacuums, rug shampooers, floor scrubbers, cleaning supplies, and toilet paper stock.
b. Provide areas for the storage and pickup of trash and recyclable materials. Provide outside storage areas for roll-out trash dumpsters and recycling bins.

11. Utility Equipment Spaces

Utility equipment spaces house mechanical, electrical, telecommunications, and elevator equipment.

a. Mechanical and electrical rooms must be easily accessible for building services and equipment, including steam, chilled water, domestic water, fire protection, electrical, and telecommunications. Provide adequate space around equipment for service, repair, and maintenance.

b. At least one electrical and telecommunications closet is required on each floor of each wing, and must be accessible from a public corridor. Separate rooms are required for electrical panels and telecommunications equipment.

F. Athletic Space Standards

1. Interior

Athletic spaces are those used primarily for athletic activities. They include gymnasiums, swimming pools, running tracks, and exercise rooms; squash, racquetball, handball, basketball, and tennis courts; ice skating rinks; and locker rooms. The design and construction of athletic spaces must conform to the following rules for the listed sports:

- Basketball—USA Basketball rules
- Fencing—U.S. Fencing Association rules
- Gymnastics—USA Gymnastics rules
- Handball—Team Handball rules
- Ice Hockey—USA Hockey, Inc. rules
- Ice Skating (figure and speed skating)—U.S. Figure Skating rules
- Racquetball—U.S. Racquetball Association rules
- Squash—U.S. Squash Racquets Association rules
- Volleyball—USA Volleyball rules
- Track and Field—IAAF Rules (International Association of Athletic Federations)
2. Exterior

Outdoor athletic spaces are those used primarily for outdoor athletic activities as described in the project program. The design and construction of outdoor athletic spaces must conform to the following rules for the listed sports:

- Baseball: turf surface—USA Baseball rules
- Equestrian—American Horse Show Association rules
- Field Hockey—U.S. Field Hockey Association rules
- Football: turf surface, scoreboard—NCAA rules
- Lacrosse: turf surface—NCAA Men's rules
- Rowing—United States Rowing Association rules
- Rugby: turf surface, scoreboard—USA Rugby rules
- Sailing—United States Sailing Association rules
- Soccer: turf surface—U.S. Soccer Federation rules
- Softball: turf surface—Amateur Softball Association rules
- Tennis—U.S. Tennis Association rules
- Track and Field—IAAF Rules (International Association of Athletic Federations)


b. The design and construction of swimming pools and water sports facilities must conform to the following rules for the listed sports:

- Diving—United States Diving, Inc. rules
- Swimming—USA Swimming, Inc. rules
- Synchronized Swimming—U.S. Synchronized Swimming, Inc. rules
- Underwater Swimming—Underwater Society of America rules
- Water Polo—U.S. Water Polo rules
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General Design Conditions

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A. Summary

This section contains general system and architectural design and performance requirements, equipment installation guidelines, disposal guidelines, and design team coordination requirements.

B. System and Architectural Design and Performance Requirements

In addition to the design, performance, and coordination requirements contained in this section, the designer must design Yale University facilities to applicable codes and industry standards.

1. General
   a. Cut at least one section in every mechanical room.
   b. For continuity of critical services, design in redundancy and provide sufficient isolation for maintenance.
2. **Vibration Control**
   
a. Carefully evaluate each installation of vibration producing equipment for transmission of vibrations to the building structure. In some cases, special equipment and techniques are required due to the presence of extremely sensitive laboratory devices in the building, particularly the Medical School, Science Hill, and Engineering School areas. Determine the need for special equipment and techniques in all locations.

b. Be aware that some of the buildings are of very light construction and require special treatment for any vibration-producing equipment. To reduce transmission problems, flexible duct connectors should be at least 6" long and fire resistant.

c. Give special attention to the need for pipe and conduit isolation from vibration sources.

3. **Seismic Design**
   
a. The design of seismic controls must be performed by a professional engineer licensed to practice in the State of Connecticut. The engineer is responsible for the complete design, the verification of seismic zone classification, and the selection of all seismic restraint systems and components, including all vibration isolation elements.

b. Design piping, hangers, and braces to meet State of Connecticut building codes. The hanger supplier is not responsible for seismic design. The design of anchors, thrust restraints, guides, and other similar components is the responsibility of the engineer.

4. **Noise Control**
   
a. See Table 1 for room background noise guidelines. Selection criteria depend on user or space sound quality needs. Higher or lower values might be appropriate and should be based on an analysis of space use, economics, and user needs. An experienced acoustical consultant should be retained for guidance on acoustical criteria spaces below RC30 and on all performing arts spaces. Verify sound criteria with local codes.
b. Engineer systems to achieve specified sound levels, and use sound attenuation, as necessary. The noise from cooling towers might require special consideration. Consult local codes for maximum ambient noise. See Table 1 for maximum ambient sound guidelines.

Table 1. Room Background Noise Design Guidelines

<table>
<thead>
<tr>
<th>Space</th>
<th>Noise Criteria (NC)</th>
<th>Room Criteria (RC)</th>
<th>Maximum dbA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical rooms</td>
<td></td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Primary electrical rooms</td>
<td></td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Stairs</td>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toilet rooms</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telecom data rooms</td>
<td>30–40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elevator machine rooms</td>
<td></td>
<td></td>
<td>85</td>
</tr>
<tr>
<td>Laboratory storage spaces</td>
<td>45–55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shipping &amp; receiving spaces</td>
<td>45–55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breakout rooms</td>
<td>30–40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multi-purpose rooms</td>
<td>40–50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratories</td>
<td>40–45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory work spaces</td>
<td>40–45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory support spaces</td>
<td>40–50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory equipment rooms</td>
<td>45–55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private offices</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open-plan offices</td>
<td>30–40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corridors</td>
<td>40–45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conference &amp; seminar rooms</td>
<td>25–35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instrumentation rooms</td>
<td>30–40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classrooms</td>
<td>25–30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large lecture rooms</td>
<td>25–30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gymnasiums &amp; natatoriums</td>
<td>40–50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Music practice rooms</td>
<td>30–35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drama theaters</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outdoor ambient</td>
<td>60 (1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) At 120 feet.
5. **Space Efficiency**
   Minimize the floor area required while providing specified spaces, space relationships, and required circulation and services areas.

6. **Energy Efficiency**
   Minimize energy consumption while providing the specified function, amenity, and comfort requirements. See Section 01352: Sustainable Design Requirements.

7. **Water Consumption**
   Minimize water consumption. See Section 01352: Sustainable Design Requirements.

8. **Waste (Trash/Rubbish) Removal**
   See the project program and Section 01352: Sustainable Design Requirements.

9. **Ease of Operation**
   Provide facilities, equipment, and systems that personnel can operate easily with a reasonable level of training. Minimize the need for specialized training in the operation of specific systems or equipment. Identify all equipment and systems for which the manufacturer recommends or provides training. See Section 01810: Commissioning and Section 01820: Demonstration and Training.

10. **Ease of Maintenance**
    - Minimize the amount of required maintenance.
    - For new buildings, provide a means of washing exterior windows.

11. **Ease of Repair**
    Elements that do not meet the specified requirements for ease of repair may be used under the following conditions:
    - They meet the specified ease of replacement requirements for elements not required to have a service life span equal to that specified for the project
    - The service life expectancy analysis and life-cycle cost substantiation for the specified service life are provided
    - Yale University accepts them
12. Ease of Replacement

Design provisions for replacement without undue disruption of building operations for elements not required to have a service life span equal to that specified for the project.

13. Acoustical Performance

Limit sound transmission through the substructure as follows.

a. Maintain ambient sound levels in enclosed, occupied, substructure spaces within the noise criteria ranges indicated in Tables 2 and 3.

b. Maintain the maximum average daytime and nighttime exterior noise levels from sound sources at building entrances and exists in accordance with City of New Haven acoustical requirements.

c. Achieve the outdoor–indoor airborne sound level reductions for perimeter spaces indicated in Table 3 and when tested in accordance with ASTM E 966 and classified in accordance with ASTM E 413 (R94).

d. Use substructure elements that will not resonate at frequencies that are characteristic of ambient underground sound and vibration sources at the project site. Isolate the structure from internal and external sources of vibration adjacent to and on the site.

e. Design and select materials that dampen and maintain the sound of precipitation on the roof and of water flowing down building sanitary and storm risers to the interior ambient sound levels in Table 3.
Table 2. Airborne Sound Design Guidelines—Interior Space to Interior Space

<table>
<thead>
<tr>
<th>Space</th>
<th>Noise Criteria</th>
<th>Space</th>
<th>Noise Criteria</th>
<th>Minimum Noise Isolation Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Similar Function</td>
<td>20-30</td>
<td>Similar Function</td>
<td>30-40</td>
<td>36</td>
</tr>
<tr>
<td>Quiet Space</td>
<td>20-30</td>
<td>Moderate</td>
<td>30-40</td>
<td>39</td>
</tr>
<tr>
<td>Quiet Space</td>
<td>20-30</td>
<td>Noisy</td>
<td>40-50</td>
<td>42</td>
</tr>
<tr>
<td>Quiet Space</td>
<td>20-30</td>
<td>Very Noisy</td>
<td>50-60</td>
<td>48</td>
</tr>
<tr>
<td>Moderately Noisy Space</td>
<td>30-40</td>
<td>Noisy</td>
<td>40-50</td>
<td>36</td>
</tr>
<tr>
<td>Moderately Noisy Space</td>
<td>30-40</td>
<td>Very Noisy</td>
<td>50-60</td>
<td>42</td>
</tr>
<tr>
<td>Adjacent Music Practice Rooms</td>
<td></td>
<td></td>
<td></td>
<td>55</td>
</tr>
<tr>
<td>Adjacent Theatres</td>
<td></td>
<td></td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>Adjacent Offices Requiring</td>
<td></td>
<td></td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>High Speech Confidentiality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3. Airborne Sound Isolation—Outdoor Source to Interior Space

<table>
<thead>
<tr>
<th>Space</th>
<th>Noise Criteria</th>
<th>Exterior Source</th>
<th>dBA</th>
<th>Outdoor–Indoor Level Reductions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet Space</td>
<td>20–30</td>
<td>Low</td>
<td>&lt;40</td>
<td>30</td>
</tr>
<tr>
<td>Quiet Space</td>
<td>20–30</td>
<td>Moderate</td>
<td>40–60</td>
<td>33</td>
</tr>
<tr>
<td>Quiet Space</td>
<td>20–30</td>
<td>Loud</td>
<td>60–70</td>
<td>36</td>
</tr>
<tr>
<td>Quiet Space</td>
<td>20–30</td>
<td>Very Loud</td>
<td>70–80</td>
<td>42</td>
</tr>
<tr>
<td>Quiet Space</td>
<td>20–30</td>
<td>Extremely Loud</td>
<td>&gt;80</td>
<td>52</td>
</tr>
<tr>
<td>Moderately Noisy Space</td>
<td>30–40</td>
<td>Moderate</td>
<td>40–60</td>
<td>30</td>
</tr>
<tr>
<td>Moderately Noisy Space</td>
<td>30–40</td>
<td>Loud</td>
<td>60–70</td>
<td>33</td>
</tr>
<tr>
<td>Moderately Noisy Space</td>
<td>30–40</td>
<td>Very Loud</td>
<td>70–80</td>
<td>36</td>
</tr>
<tr>
<td>Moderately Noisy Space</td>
<td>30–40</td>
<td>Extremely Loud</td>
<td>&gt;80</td>
<td>37</td>
</tr>
<tr>
<td>Noisy Space</td>
<td>40–50</td>
<td>Loud</td>
<td>60–70</td>
<td>30</td>
</tr>
<tr>
<td>Noisy Space</td>
<td>40–50</td>
<td>Very Loud</td>
<td>70–80</td>
<td>33</td>
</tr>
<tr>
<td>Noisy Space</td>
<td>40–50</td>
<td>Extremely Loud</td>
<td>&gt;80</td>
<td>36</td>
</tr>
<tr>
<td>Very Noisy Space</td>
<td>50–60</td>
<td>Very Loud</td>
<td>70–80</td>
<td>30</td>
</tr>
<tr>
<td>Very Noisy Space</td>
<td>50–60</td>
<td>Extremely Loud</td>
<td>&gt;80</td>
<td>33</td>
</tr>
</tbody>
</table>
14. Appearance

Design and select materials to provide the following exterior appearance requirements and characteristics.

a. The materials must be compatible with adjacent buildings on campus.

b. The materials must match the materials on the existing building.

c. Comply with the requirements of the federal historic district in which the project is located.

d. Comply with requirements of the local architectural control or review commission regulating the area in which the project is located.

e. Glazing appearance.

   (1) Tint—use as little tint as possible while complying with other requirements.

   (2) Reflectivity—do not use glass that has been treated to increase its natural reflectivity.

f. Cleanliness of exterior surfaces.

   (1) Prevent the attraction and adherence of dust and airborne dirt and soot. Minimize the appearance of settled dust and dirt.

   (2) Exterior surfaces must be washed reasonably clean by normal precipitation.

   (3) Prevent precipitation from washing settled dust and dirt over surfaces exposed to view.

g. Conceal mechanical equipment, plumbing equipment, electrical equipment, piping, conduit, and ducts from view from the street, from windows in the project that overlook the roof, and where possible, from windows in adjacent buildings overlooking the roof. Design permanent concealments for rooftop items using substantial construction other than screens. Coordinate with the HVAC design engineer on concealments for lab fans or duct discharges.

h. Roof color must be compatible with energy efficiency design. Use materials on roofing surfaces exposed to view that will conceal dirt. Arrange roof drainage to eliminate ponding.
15. Health and Safety

a. Design and select materials that provide fire resistance in accordance with code.
   
   (1) All exterior enclosure materials must be non-combustible, without exception.

   (2) Facades enclosing stairs must have a fire resistance rating of two hours, unless applicable laws require a higher rating.

   (3) Facades exposing stairs or stair enclosures must have a fire resistance rating of one hour within 10 ft (3 m)—horizontally and vertically—of a stair enclosure.

b. Prevent the accumulation and subsequent penetration into occupied spaces of harmful chemicals and gases, such as radon and methane, in spaces below the substructure.

c. Provide permanent protection against the infestation of construction by ground dwelling termites and other vermin.

d. Design and select materials to protect pedestrians and building occupants in accordance with code and with the following additional requirements.

   (1) Prevent ice and snow from falling off building elements onto pedestrians, building occupants, and vehicles.

   (2) Protect pedestrians, building occupants, and vehicles from objects accidentally dropped from elevated observation decks, balconies, or plazas.
e. Design and construct to provide physical security in accordance with the following requirements.

1. For ground-level opaque elements, use materials that give the impression of strength to discourage opportunistic attempts at intrusion. At a minimum, such materials must meet ASTM F 1233 Class I and ASTM F 476 (R96) Grade 10 forced entry resistance requirements, adapted to suit the element.

2. Minimize the size of ground-level glazed elements, and locate them in areas under surveillance by Yale University staff at their normal workstations.

3. Ground-level glazing must have a UL 972 burglary resistant rating.

4. Doors must meet ASTM F 476 (R96) or ASTM F 842 requirements, Grade 10, as appropriate.

5. Provide window protection adequate for the conditions or location.

e. Design and select materials to provide natural ventilation in accordance with code and with the following additional requirements.

1. The ventilation opening area must be at least four percent of the total floor area for each room. This ventilation requirement is not applicable to bathrooms, toilet compartments, closets, halls, and storage or utility spaces.

2. The ventilation area must be at least 10 percent of the wall area for each floor, equally distributed on two elevations.

3. Where possible, design to provide cross ventilation.

4. Design in accordance with the requirements of Section 01352: Sustainable Design Requirements.

g. Design and construct the shell to minimize the potential effects of an explosion on building occupants and structural members.

h. Design to prevent the growth of fungus, mold, and bacteria on surfaces and in concealed spaces.
i. Design to prevent damage to occupants, structure, services, and contents from lightning strikes.
   
   (1) Provide protection equivalent to that specified in NFPA 780-1997. Supplementary strike termination devices, ground conductors, and grounding electrodes are required only where the integral portions of the structure cannot perform those functions.
   
   (2) Prevent lightning strikes from damaging or traveling along landscape features within 10 ft (3 m) of a structure.
   
j. Design and construct to comply with code and with the following additional requirements for hazardous construction materials.

   (1) All existing friable asbestos and materials containing asbestos must be removed or abated to the extent required by federal, state, and local regulations, using the specified procedures.
   
   (2) All existing lead-based paint must be removed or abated to the extent required by federal, state, and local regulations, using the specified procedures.
   
   (3) All existing equipment containing PCBs and materials contaminated with PCBs must be removed using the procedures specified by federal, state, and local regulations.

k. Design and construct to comply with local, state, and national indoor air quality codes, with ANSI/ASHRAE 62 and applicable addendums, and with Section 01352: Sustainable Design Requirements.
16. Physical Security

In addition to any provisions that may be required by law or code, design and construct both exterior and interior spaces to incorporate accepted principles of crime prevention through environmental design, using natural (as opposed to technological) methods of providing surveillance, access control, and territorial reinforcement, wherever possible.

a. For purposes of physical security, elements at ground level are defined as any elements within 20 feet (6 m) of the ground, grade, or adjacent paving.

b. Security zones are defined as follows.

(1) Public access zone—an area to which the public has free access, including public corridors, grounds, and parking lots.

(2) Reception zone—an area to which the general public has access but beyond which access is restricted at all times.

(3) Operations zone—an area to which only employees (and visitors with a legitimate reason to be there) have access.

(4) Secure zone—an area to which access is always controlled and which is monitored continuously.

(5) High-security zone—an area indicated in project program, and an area named "vault", "secure file room," or "cash room."
C. Installation Guidelines

1. Access to Equipment

Select and locate all equipment and accessories with due consideration for easy routine servicing and feasibility of major servicing, including removal and replacement of equipment.

a. Provide direct elevator access to mechanical spaces on the lower and upper floors and roof for maintenance purposes.

b. Provide a fixed ladder and/or catwalk for any equipment that requires maintenance access (including valves) and is not readily accessible from a 6-foot high portable ladder. To the extent possible, place valves and equipment so that a ladder is not needed.

c. Provide access to equipment and pull spaces and a means for removing and replacing the largest and/or heaviest equipment. Consider adding a beam attached to the structure to move or replace large motors, compressors, and other equipment.

d. Avoid roof-mounted equipment for critical applications. Access to roof-mounted equipment is difficult, and rooftop working conditions for maintenance personnel are not as safe as working conditions for indoor installations.

e. Provide at least OSHA and NEC clearance requirements at all mechanical equipment service points for personnel access and working space. For switchgear and other electrical equipment, follow National Electrical Code recommendations for required clearances.

f. Automatic control valves and damper operators must be exposed or equipped, with access doors or panels. The minimum access door or panel size is 12" x 12" clear.

g. Fans, fan coil units, and similar components located above hung ceilings must have adequate access for such services as lubrication and filter changes. “Lay-in” ceiling boards are not satisfactory because of difficulty with smudging and breaking. Coordinate unit placement with the ceiling grid, walls, and doorways.

h. Locate thermometers and gauges, as well as thermometer wells and gauge taps, for easy reading (and changing).
i. Where necessary, provide extended grease fittings for concealed or hard-to-reach bearings.

j. Provide adequate branch valving to allow for servicing without major shutdowns.

k. Equip branch piping serving each floor with shut-off valves.

l. Equip branch mains serving fan-coil units, reheat boxes, induction units, convectors, and similar units with flow-measuring devices and balancing valves.

m. Avoid routing piping through rooms containing electrical or communications equipment. Where there is no other choice for routing, provide stainless steel drain pans under pipes that pass overhead and within 2' of any switchboard, motor, or controller. Drain pans must be 20 oz, copper pans at least 4" wider than the outside edge of the pipes. Drain pans must be properly stiffened and braced with brass angles and supported to prevent sagging. Provide a turned-up edge rolled over stiff brass wire on each side. Seams must be soldered and watertight. Provide 1" diameter drip pipe from the pan down to the nearest drain.

n. Locate equipment to allow the necessary clearance for removing coils and other sub-assemblies.

o. Provide conveniently-located access doors to all enclosed areas housing mechanical equipment.

p. Provide lighting and power for servicing equipment.

2. **Access to Piping Risers**

   Where required by the building design, access to valves and/or traps should be easy and practical. Access doors should be sectionalized, as necessary, for ease of removal and replacement. Install Lamicore name plates on access doors to identify the services available in pipe chases.
3. Mechanical Room Layout

a. Design mechanical rooms to provide a minimum clearance of 3’ clear around all units, boilers, heat exchangers, pumps, fans, and similar equipment. Provide a minimum clearance of 4’ in front of electrical panels.

b. Provide the manufacturer's recommended minimum service areas around all equipment.

c. Provide a full-length coil pull space. Show all coil pull spaces and access ways on the drawings.

d. Arrange mechanical rooms so that any piece of equipment within the room can be removed in one piece, without removing or disassembling any other piece of equipment within the room. On drawings, outline areas required for coil, shaft and blower removals.

e. Access to mechanical rooms must be from public spaces. Access through program spaces is not permitted. Access must be safe and easy (normal stairs, not ladders) and allow for easy movement of equipment and maintenance supplies (elevators or hoistways).

f. Sections or profiles of underground piping must show elevation (with respect to grade), roads, and possible conflicting utilities.

D. Disposal Guidelines

1. Review the project with the Yale University Project Manager during the design-development phase to identify salvageable equipment and hazardous waste.

2. Drawings must identify salvageable equipment and include the requirement that such equipment be delivered to the physical plant loading dock at 20 Ashmun Street or other designated location. The following materials are considered salvageable, unless refused by Yale University:
   - Meters, meter sockets, and test switches
   - Transformers (10 kva and larger)
   - Fire alarm equipment
   - Other equipment designated by the Yale University Project Manager
3. Ensure that hazardous waste disposal is in accordance with Division 1 standards.
4. All removed equipment that will not be reinstalled becomes the property of the contractor, and must be removed from the site and disposed of legally.

E. Coordination Requirements

1. Refer to Yale University’s Guidelines for New and Remodeled Buildings, Specification Sections 01051 and 01052, for the coordination of items to be included in the contract documents.
2. The design team is responsible for coordinating materials and equipment locations to ensure that adequate space is available in the general location of each component.
3. Coordinate equipment emergency power requirements with the electrical engineer. Equipment requiring emergency power includes life safety equipment, the control compressor, and the DDC controls system.
4. Verify that adequate clearances have been allowed for expansion, and coordinate space requirements with engineers from all disciplines.
5. Coordinate control and electrical systems wiring requirements with the electrical engineer.
6. Coordinate access space and door requirements with engineers from all disciplines.
7. Verify that electrical outlets have been provided for servicing remote and rooftop equipment.
8. Coordinate the requirements for motor starters, disconnects, and variable-frequency drives with the electrical engineer.
9. Verify that drain line sizes for backflow preventers are adequate to handle the flow if the reduced-pressure backflow preventer should fail and flow through the emergency drain port.
10. Verify with the plumbing engineer that make-up water is available at sufficient flow and pressure.
11. Verify that expansion joints have been coordinated with building expansion joint location, the structural engineer, and the structural requirements for anchoring.
12. Verify that there are accessible drains available to serve automatic vents.
13. Provide sufficient ventilation in mechanical and utility rooms to accommodate heat loads and noxious gases.

14. Ensure that adequate space is available for piping that must pitch.

15. Do not route piping through electrical rooms; mount the heating coil outside the space and duct heated air in.

16. Do not route piping above electrical switchgear. If there is no other alternative, provide drain pans with drain lines while maintaining maximum space for conduits.

17. Provide hose bibs in mechanical rooms and at rooftop equipment.

18. Coordinate freeze protection electrical heat tracing requirements with the electrical engineer.

19. Coordinate metering requirements with the plumbing and electrical engineers.

20. Coordinate gas train requirements with Yale University’s insurance carrier.

21. Coordinate electrical service requirements for fire system tamper and flow switches, fire pumps, and control panel with the electrical engineer.

22. Provide a ball valve with 3/4" hose thread and a cap at all low points to drain equipment and piping.

End of Section
00701
Architectural Design
Conditions

This document provides design standards only, and is not intended for use, in whole or in part, as a specification. Do not copy this information verbatim in specifications or in notes on drawings. Refer questions and comments regarding the content and use of this document to the Yale University Project Manager.

A. Summary

This section contains general architectural design criteria.

B. Basic Design

1. Provide structure and exterior enclosure as required to safely support the completed and occupied building. Unless otherwise indicated, provide permanently enclosed spaces for all functional areas shown in the project program. Provide a physical enclosure that keeps out weather, unwelcome people, animals, and insects, without requiring specific action by the occupants. The enclosure must also enable convenient movement by the occupants between the inside and outside of the building, provide desirable natural light, and provide views from inside to outside where required by the project program. Provide level floor areas, comfortable ceiling heights, and essentially vertical walls.
2. The structure and envelope comprise the following elements.
   a. Foundations—structures that transfer the dead loads, live loads, and environmental loads of completed buildings to the earth in such a way that the building is supported evenly and without movement.
   b. Basements—space-enclosing elements below grade, including necessary excavation, structural walls and floors, and other enclosure elements such as waterproofing and thermal insulation.
   c. Superstructure—all elements forming floors and roofs above grade and within basements, including the elements necessary for their support, insulation, fireproofing, and firestopping.
   d. Exterior enclosure—all essentially vertical elements forming the separation between exterior and interior conditioned spaces, including exterior skin, components supporting weather barriers, and jointing and interfacing components. The exterior enclosure does not include the interior skin, unless it is an integral part of the enclosure.
   e. Roofing—all elements forming weather and thermal barriers at horizontal and sloped roofs and decks, and at roof fixtures.
   f. Elevated floors—floor construction above grade and within basements, including balcony, mezzanine, and ramp floors; floors elevated for access; stair construction (if part of the structure); and roof decks intended for occupant live loads. Elevated floor construction also includes the elements necessary for support, insulation, fireproofing, and firestopping.
   g. Roofs—roof construction, including canopies, and the elements necessary for support, insulation, fireproofing, and firestopping.
   h. Roof coverings—weather barriers, vapor retarders, insulation, wearing surfaces, flashings, water collectors, and conductors, including coverings over plaza decks, balconies, and other exposed floors.
   i. Roof openings—skylights, ventilation openings, access openings, and other roof opening elements.
   j. Roof fixtures—all elements attached to the roof, except equipment or services.
C. Amenity and Comfort

Designs must conform to the following amenity and comfort standards.

1. Thermal Performance

Provide the thermal resistance necessary to maintain specified interior comfort levels in accordance with code and the following thermal performance and energy efficiency requirements.

a. Portions of the substructure in contact with the earth and enclosing conditioned space must have an average maximum thermal transmittance U-value of 0.15 IP. The entire shell must have a maximum U-value of 0.06 IP.

b. Provide an energy efficient design using the procedures and values specified in ASHRAE 90.1, including addendums. The building must consume at least 10% less energy than that of an equivalent, minimally-compliant baseline building, as demonstrated by comparing the actual design energy cost to the energy cost budget (both calculated in accordance with ASHRAE 90.1) of a prototype building.

2. Condensation

There must be no condensation on interior surfaces under normal interior temperature and relative humidity conditions during 97.5% of the days in the coldest three months of the year. The condensation resistance factor (CRF), when tested in accordance with AAMA 1503.1, is that necessary to meet this requirement.

3. Air Infiltration

The maximum air infiltration is 0.06 cfm (0.0003 cu m/s) per square foot (square meter) of exterior surface area, measured in accordance with ASTM E 283 at a differential pressure of 6.24 psf (298 Pa).

a. If necessary, use a supplementary air barrier to maintain performance over the entire shell.

b. Use a method of sealing joints between elements that is effective given available construction practices.
4. **Water Penetration**
   Prevent ground water penetration into the interior of the building under any circumstances.
   
a. Design and select materials to prevent water penetration into the interior of the building under conditions of rain driven by 50 mph (80 km/h) wind.
   
b. Conduct a static pressure test of a mock-up, in accordance with ASTM E 331, at 2.86 psf (137 Pa) and 5.0 gal/sf/hr (3.4 L/sq m/min).
   
c. Where the interior skin is not an integral part of the exterior enclosure, test without the interior skin installed.

5. **Water Accumulation**
   Prevent water accumulation in crawl spaces or open areas adjacent to the substructure.

6. **Run-Off**
   Direct water run-off to storm drains without splashing or dripping. Design with a primary and backup drainage system. Drains in the roof field are preferred on low slopes.

7. **Grounding**
   When structural members are used to ground electrical systems, design to prevent electrical shock to occupants.

8. **Roof Worker Safety**
   a. Provide a safe design with the safety measures required by code.
   
b. Provide permanent access to all areas of the roof in the form of stairs or fixed ladders.
   
c. Provide permanently installed supports for equipment used for cleaning windows and other glazed areas of the shell.
D. Structure

Designs must conform to the following structural standards.

1. Capacity

Provide load bearing substructure members as required by code and designed to distribute dead loads, live loads, and environmental loads so that the bearing capacity of the soil is not exceeded.

   a. Extend bearing portions of the substructure to levels below the frost line but not less than 4 ft (1.2 m) below grade.

   b. Provide:
      - Spread footings that do not exceed the allowable soil bearing capacity
      - Caissons or drilled piers that bear on rock
      - Piles that provide adequate friction to withstand loading
      - Other foundation systems acceptable to governing authorities

2. Dead Loads

Accommodate dead loads from the weights of building materials, the construction itself, and all fixed service equipment.

3. Live Loads

Accommodate live loads from building use and occupancy, either uniformly distributed loads, as prescribed by code, or concentrated loads—whichever are more demanding structurally.

   a. Uniformly distributed loads—as required by code for building occupancy.

   b. Concentrated loads—as required by the project program and building design.

   c. Special floor loads.

      (1) For library compact shelving areas—300 psf (1465 kg/sq m) uniform live load.

      (2) For removable access floors—150 psf (732 kg/sq m) uniform live load and 300 pounds (136 kg) concentrated load at the center of each 24" (600 mm) span.
4. **Environmental Loads**

Accommodate environmental loads from all environmental forces in accordance with code and the following structural design requirements.

a. Lateral soil load is the lateral soil pressure adjacent to vertical substructure elements, including the potential surcharge from fixed or moving loads and potential hydrostatic pressure.

   (1) Increase lateral pressure assumptions if expansive soils have been identified by a geotechnical investigation, unless expansive soils are excluded from backfill.

   (2) The lateral soil load must be at least 45 psf per ft (7.07 kN/sq m per m) of depth.

b. Vertical soil load is the full hydrostatic pressure applied over the entire substructure area. Increase vertical pressure assumptions if expansive soils have been identified by a geotechnical investigation, unless expansive soils are removed and replaced by non-expansive soils to a minimum depth of 24" (610 mm) below horizontal substructure elements.

c. Design to resist the pressures caused by wind in any direction as required by code.

d. Design to resist snow loads as required by code but not less than 10 psf (4.8 kPa), a snow exposure factor of 0.7, and a snow load importance factor of 1.0. Roof opening elements must exceed code requirements by 15%.

e. Design to resist loads from ponding rainwater when the primary drainage system is blocked.

f. Seismic design must comply with code provisions.

g. If the project is located in a special flood hazard area, design to resist loads from water in accordance with ANSI/ASCE 7.
5. **Special Loads**  
Accommodate special loads as required by the project program.  
a. In addition to loads defined by code, design for loads from moving elevators.  
b. If the design method is not specifically prescribed by code, design in accordance with ANSI/ASCE 7.

6. **Shell Elements**  
a. In instances where shell elements are engineered by their manufacturer or fabricator, rather than by the engineer-of-record, the manufacturer or fabricator must:  
   • Employ a licensed structural engineer to design structural elements  
   • Have at least five years experience in the design and manufacture of similar structures  
b. Elements engineered by their manufacturer or fabricator, rather than by the engineer-of-record, are not acceptable for the superstructure.

7. **Construction Loads and Erection Stresses**  
Accommodate temporary construction loads and erection stresses during construction.

E. **Durability**  
Designs must conform to the following durability standards.

1. **Service Life Span**  
Service life span is the same as building service life, with the following exceptions.  
a. Load-bearing structural members—a minimum of 100 years, with no anticipated deterioration when protected as specified and a minimum service life of 25 years for protective elements.  
b. Wall primary weather-barrier elements—a minimum 50-year functional and aesthetic service life, excluding joint sealers.  
c. Transparent elements (glazing)—the same as other wall primary weather-barrier elements, except for accidental breakage, which is considered normal wear-and-tear.
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d. Joint sealers—a minimum of 20 years before replacement.

e. Surfaces exposed to view—a minimum 20-year aesthetic service life.
   Deterioration includes color fading, crazing, and delamination of applied coatings.

f. Roof covering weather barriers—a minimum of 20 years, fully functional.

2. Weather Resistance

Design and select materials to minimize deterioration due to precipitation, sunlight, ozone, normal temperature changes, salt air, and atmospheric pollutants. Deterioration includes corrosion, shrinking, cracking, spalling, delamination, abnormal oxidation, decay, and rot.

a. For surfaces exposed to view, deterioration adversely affecting the aesthetic life span includes color fading, crazing, and delamination of applied coatings.
   (1) Minimize the use of materials with separate coated finishes.
   (2) At a minimum, coating performance must meet AAMA 2604 standards.
   (3) Coatings must be resistant to salt spray. There must be no deterioration of coatings when tested in accordance with ASTM B 117 for a 1000-hour exposure with 5% salt fog at 95°F (35°C).

b. Joint components and penetration seals must be capable of resisting expected thermal expansion and contraction. Wherever possible, use overlapping joints that shed water.

c. For transparent elements (glazing) there must be no change in haze, light transmission, or color during the entire expected service life. Test in accordance with ASTM D 1003. There must be less than a 1% change in haze, light transmission, and color over two years of exposure when tested after natural exposure conditions or when tested after exposure to accelerated light and water conditions simulating natural exposure at the site. Accelerated exposure must be documented with a comparison to natural conditions.

d. The low service temperature is equal to the historically-recorded low. The high service temperature is equal to that expected due to any combination of air temperature and heat gain from solar and other sources.

e. Freeze-thaw resistance must be adequate for the climate at the site.
f. In locations exposed to the outdoor air or in potential contact with moisture inside shell assemblies, use only corrosion-resistant metals as defined in this section.

g. Do not use materials that are adversely affected by ozone.

3. Impact Resistance

Design and select materials to resist impact damage in accordance with code and the following additional requirements. Minimum performance values for individual shell elements are also specified in other sections of these standards.

a. Design and select materials to minimize damage from windborne debris propelled at up to 35 mph (56 km/h).

b. Design and select materials to resist damage from hail as large as 1/2 inch (12 mm).

c. At elements adjacent to traffic lanes, design and select materials to resist damage from accidental passenger vehicle impacts at a maximum velocity of 5 mph (8 km/hr).

d. Design and select materials to minimize damage due to potential vandalism.

e. Design and select materials to resist damage from perching, nesting and feeding birds.

4. Moisture Vapor Transmission

Design to prevent deterioration of materials due to condensation of moisture vapor inside assemblies.

a. If necessary, use a supplementary vapor retarder to meet moisture vapor transmission requirements.

b. Use a method of sealing joints between elements that is effective given available construction practices.
5. **Wear Resistance**
   Design and select materials to provide resistance to normal wear-and-tear in accordance with code and the following additional requirements.
   a. Design and select materials to minimize degradation from rubbing and scratching caused by pedestrians for elements within their reach.
   b. Design and select materials to minimize degradation caused by windblown sand, acid, and rain.

6. **Corrosion Prevention**
   Provide sufficient supplementary protection for underground metal elements to completely prevent corrosion throughout their service life, without maintenance.
   a. 3" (150 mm) of concrete cover is considered to be permanent protection.
   b. Provide cathodic protection if any of the following is true (coatings or wrappings are not considered sufficient protection for elements falling under these criteria).
      (1) Metal elements are buried in a soil environment known to cause corrosion on similar nearby structures.
      (2) Metal elements are buried in a soil environment in which stray DC electrical currents are present.

7. **Ambient Temperature Change**
   Allow for daily expansion and contraction within and between elements caused by ambient temperature changes within a range from the most extreme low temperature to 70°F (39°C) greater than the most extreme high temperature, in any year, without causing detrimental effects to components and anchorage.

8. **Expansion Control**
   Provide for expansion and contraction of all construction materials for both interior and exterior applications.
F. Products and Systems

1. Unless directed otherwise in the project program, do not use:
   - Pre-engineered metal buildings
   - Air-supported structures
   - Different metals subject to galvanic action in direct contact with each other
   - Aluminum in direct contact with concrete or cementitious materials
   - Materials and products that require field finishing on surfaces exposed to the weather
   - Metal siding
   - Treated wood or masonry for foundations
   - Non-reinforced, load-bearing masonry
   - Unfireproofed structural steel
   - Load-bearing wood stud walls, wood joists and rafters, wood decking, and minor structural steel

2. Do not use the following systems:
   - Lift-slab construction
   - Dead-flat roofs
   - Surface-bonded masonry construction
A. Summary

This section contains general interior design criteria.

B. Basic Design

1. Provide the physical separation between spaces required by the project program. Interior construction must meet the fire ratings required by code; provide appropriate security between adjacent spaces; and maintain the visual, acoustical, olfactory, and atmospheric isolation necessary for desirable conditions in each space.

2. Provide appropriately finished interiors for all spaces required by the project program. Equip finished interior spaces with interior fixtures appropriate for specific occupancies.

3. Interior construction comprises the following elements, which are necessary to subdivide and finish space enclosed within the shell, including applied interior surfaces of the exterior enclosure.
   a. Partitions—all types of space dividers, including demountable and operable partitions.
   b. Interior doors—all interior doors, except elevator doors, including the hardware and frames.
   c. Interior windows—all fixed and operable windows, including the frames and casings.
d. Other interior openings—include utility openings such as hatches and access panels, louvers, and vents.

e. Stairs and ramps—the interior and exterior stair and ramp elements that are not part of the superstructure or exterior enclosure.

f. Interior finishes—all functional and decorative applied interior finishes, including those for secondary support structures.

4. Interior fixtures comprise the following functional items, which are permanently attached to interior construction (walls, ceilings, and floors) and are necessary for complete and proper functioning of spaces required by the project program, except items classified as equipment or integral components of service systems.

a. Identifying devices—informational accessories, including room numbers, signage, and directories.

b. Storage fixtures—non-furniture items intended primarily for storing or securing objects, materials, and supplies, including cabinets, casework, wardrobes, closet fixtures, lockers, and shelving.

c. Window treatment—non-furnishing accessories for light control, solar heat gain, privacy, and view at interior and exterior windows, including blinds, shades, shutters, and curtain tracks.

d. Accessory fixtures—specialty items intended to provide service or amenity to building interiors, including toilet and bath accessories, postal fixtures, visual display surfaces, and telecommunications fixtures.

e. Fixed seating—single and multiple seating attached to the building.

f. Other interior fixtures—other items fixed to interior construction that enhance comfort or amenity in building spaces, including service wall systems, planters, and fixed ladders.
C. Amenity and Comfort

Designs must conform to the following amenity and comfort standards.

1. Cross Ventilation

Provide interior construction to facilitate natural cross ventilation.

2. View

Provide views to the building exterior or interior atria from most locations within primary interior spaces.

3. Natural Light

a. Provide ambient natural daylighting in primary spaces of an intensity adequate for essential tasks when measured on a typical overcast winter day in mid-afternoon.

b. Provide minimum light levels not less than those recommended in IESNA's Lighting Ready Reference, 1996, for the types of tasks anticipated in each space.

c. Provide ambient natural light in primary spaces that is free of excessive direct or reflected glare, as defined in IESNA RP-5, Recommended Practice of Daylighting, 1978.

d. Provide local devices to enable occupants to control brightness and glare from direct daylighting.

4. Acoustical Performance

a. Provide interiors that maintain ambient sound levels within primary spaces at levels recommended in the ASHRAE HVAC Applications Handbook, 1999, when adjacent spaces are occupied and are being used normally.

b. Provide floor-ceiling construction, including floor structure, floor finish, and ceiling finish, to insulate primary spaces from undesirable impact noise when adjacent spaces are occupied and are being used normally.
c. Provide reverberation times in primary spaces for frequencies of 500-1000 Hz as follows:
   - Classrooms: 0.6–0.8 seconds
   - Lecture and conference rooms: 0.9–1.1 seconds
   - Small theater: 1.2–1.4 seconds
   - Auditorium and multipurpose space: 1.5–1.8 seconds

d. Design and construct interiors, based on the noise criteria values in Tables 1, 2, and 3 in Section 00700: General Design Conditions, to achieve the following minimum airborne sound isolation class values between adjacent spaces, when tested in accordance with ASTM E 336-1997 and classified in accordance with ASTM E 413-1987 (R94).

5. **Odor Control**

   Prevent unpleasant odors generated within a space from affecting the occupants of adjacent spaces by providing physical isolation of the spaces, separate ventilation, or a combination of isolation and ventilation.

6. **Appearance**

   a. Provide interiors that are pleasing in appearance and do not detract from the primary functions performed in each space.

   b. Provide interior fixtures that are coordinated in design with other elements of interior construction, using compatible materials, colors, textures, and design features.

7. **Texture**

   a. Provide interior elements and surfaces textured appropriately for the primary functions to be accommodated within each space. Provide textures that are safe for occupants and require minimum maintenance.

   b. Provide durable, low-maintenance, exposed surfaces for interior fixtures that are within reach of occupants engaged in activities normal for the particular space in which they are installed.
c. Interior finishes:

(1) Use satin finishes (non-reflective rather than smooth, polished surfaces) on flat, exposed metal surfaces.

(2) Coatings not permitted on flat metal surfaces.

(3) Use polished, satin, or high-performance organic coatings on hardware and other rounded metal surfaces.

(4) Use matte, rather than glossy or polished finishes, on plastic surfaces.

(5) Use low-gloss finishes, transparent or opaque, on flat wood surfaces.

(6) Use transparent or opaque finishes, high- or semi-gloss, on curved wood surfaces.

(7) Use honed or other textured, non-polished finishes on concrete and stone surfaces.

8. Accessibility

Provide interior fixtures that disabled persons can use easily without outside assistance. Interior fixtures must comply with ADAAG-1994 standards.

9. Light and Glare

Provide interior fixtures that are not a source of direct or reflected glare.

10. Convenience

Provide interior fixtures with fittings and controls that are manageable without special instruction or the need for excessive force.

D. Health and Safety

Designs must conform to the following health and safety standards.

1. Safety

Design and provide interior construction to protect building occupants in accordance with code and the following additional requirements.

a. Protect building occupants from falling from elevated interior observation areas.

b. Protect building occupants from tripping hazards due to uneven floor surfaces or abrupt changes in floor elevation of more than 1/8 inch (3.2 mm).
c. The minimum performance values for individual interior construction elements are specified in other sections.

2. Security

At interior construction separating tenants from public circulation spaces, provide materials and systems with the same performance characteristics as specified for exterior enclosures in paragraph B.2, except for requirements related to weathering.

3. Flammability

Provide interior fixtures made of materials with a flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E 84 at all locations throughout the project.

E. Structure

Designs must conform to the following structural standards.

1. Structural Performance

Provide interior construction and fixtures to support, without damage, all loads required by code.

2. Special Loads

In addition to loads defined by code, provide for adequate support of wall-mounted or ceiling-mounted furnishings and equipment in spaces where such equipment is required by the project program or is likely to be installed after construction because of intended function. Adequate support is defined as the ability to sustain 150% of design loads without damage to the building or equipment.

3. Seismic Loads

a. Provide interior partitions at stairs and elevators that have been engineered and installed to withstand seismic forces that are 0.6 times the weight of the partition, applied non-concurrently in any horizontal direction at the partition's center of gravity.

b. Provide partitions at other than stairs and elevators that have been engineered and installed to withstand seismic forces that are 0.4 times the weight of the partition, applied non-concurrently in any horizontal direction at the partition's center of gravity.
c. Provide fire-rated ceiling assemblies that have been engineered and installed to withstand seismic forces that are 0.4 times the weight of the ceiling assembly, applied non-concurrently in any horizontal direction at the assembly's center of gravity.

d. Provide non-fire-rated ceiling assemblies that have been engineered and installed to withstand seismic forces that are 0.1 times the weight of the ceiling assembly, applied non-concurrently in any horizontal direction at the assembly's center of gravity.

e. Provide interior fixtures or portions of fixtures designed for the storage or support of people or objects that have been engineered and installed to withstand seismic forces that are 0.6 times the loaded weight of the fixture.

   (1) Application: For design purposes, apply the component seismic force non-concurrently in any horizontal direction at the component's center of gravity.

   (2) Exception: For design purposes, the contents to be included need not be more than 50 percent of the rated capacity of the interior fixture, if the supports and framing of the fixtures are designed and connected to act as braced or moment-resisting frames.

4. **Live Loads**

   Provide suspended interior fixtures or portions of fixtures designed for the storage or support of people or objects that have been engineered and installed to withstand 1.5 times the anticipated live loads, without excessive deflection or permanent distortion.

F. **Durability**

   Designs must conform to the following durability standards.

   1. **Service Life Span**

      Service life span is the same as building service life, with the following exceptions.

      a. Interior doors and other operable elements—a minimum 15-year functional and aesthetic service life.

      b. Interior ceiling finishes—a minimum 15-year functional and aesthetic service life' including suspended ceilings.
c. Interior wall and floor finishes—a minimum 10-year functional and aesthetic service life.
d. Other interior construction—a minimum 15-year functional and aesthetic service life.

2. **Wear Resistance**

   Provide interior construction and fixtures with durability suitable for the degree and type of anticipated traffic in each space.

3. **Water and Corrosion Resistance**

   In interior spaces exposed to high humidity, such as swimming pool enclosures, provide interior construction and fixtures that will not be damaged by water or high humidity, and that are inherently resistant to corrosion and rot.

4. **Ultraviolet Resistance**

   In interior spaces exposed to direct sunlight, provide interior construction and fixtures that are inherently resistant to fading and discoloration.

5. **Vandal Resistance**

   In spaces accessible to the public and not subject to continuous surveillance, provide interior construction and fixtures that are inherently vandal resistant or designed to be difficult to access or damage.

6. **Dimensional Stability**

   In interior spaces exposed to high humidity, such as swimming pool enclosures, provide interior construction that will withstand continuous or intermittent exposure without significant changes in dimension.

**G. Cleaning and Maintenance**

Provide interior construction and fixtures that will not be damaged by ordinary cleaning and maintenance operations.

1. **Cleaning**

   At swimming pool enclosures, steam rooms, laundry rooms, toilet rooms, shower rooms, trash collection rooms, and janitorial closets, provide interior construction that will allow harsh chemical cleaning, without damage.
2. **Ease of Relocation**
   When required by the project program, provide easily relocatable functional elements that define interior spaces.

3. **Ease of Use**
   a. All text on identifying devices must be English.
   b. Interior fixtures with movable components must be easy to use, without special instruction, and designed to prevent misuse.
   c. Hinges and latches must be heavy-duty and easily adjustable, with a 20-year minimum anticipated service life.
   d. Mechanical controls must be movable cranks, rotors, pulleys, and levers designed for trouble-free operation over a minimum anticipated service life of 20 years.

4. **Ease of Repair**
   Provide interior fixtures at all locations that are designed to permit repair or replacement of individual components without removing the fixture.

5. **Ease of Replacement**
   Provide interior fixtures at all locations that are modular in form and detachable from the substrate, without damaging them.

6. **Theft Resistance**
   Provide interior fixtures at all locations that are attached to substrates with concealed, tamper-resistant or tamperproof fasteners to minimize theft and vandalism.
H. Products

1. Design and construct interiors using materials and systems that comply with the criteria in this section and with the product standards in other applicable sections of the Yale University design standards.

2. Use one of the following window treatments throughout the project:
   - Window blinds
   - Window shades
   - Interior shutters
   - Recessed curtain tracks
   - Surface-mounted curtain tracks

End of Section
00703
General Plumbing Design Conditions

This document provides design standards only, and is not intended for use, in whole or in part, as a specification. Do not copy this information verbatim in specifications or in notes on drawings. Refer questions and comments regarding the content and use of this document to the Yale University Project Manager.

A. Summary
This section contains general design guidelines for plumbing systems.

B. System Design and Performance Requirements
1. Install drains at all interior water faucets.
2. Install equipment that uses large volumes of water at an elevation that does not require pumping of effluent to the city sewer.
3. Coordinate with the HVAC engineer to ensure that equipment temperatures, pressures, setpoint deviations, and monitoring points are included in the building automation system controls.
4. Provide hose bibs at all mechanical equipment the requires water for wash down.
5. Include all pumped drain high-level alarms in the controls points list.

End of Section
A. Summary

This section contains general design criteria for fire protection systems.

B. System Design and Performance Requirements

1. Include hydraulic calculations for all systems, equipment, and piping systems in the as-built documents. As-built drawings and documentation required of the mechanical engineer or contractor must be reviewed by the mechanical engineer.

2. Revise as-built drawings and documentation to reflect modifications made to any part of the facility or mechanical systems.

3. Carefully monitor and document any change in usage, installed equipment, loads, or occupancy.

4. Sprinkler spacing must allow for future growth in the following types of facilities by providing the flexibility to move partitions without relocating sprinkler heads:
   - Laboratories: 15%, to allow for additional ductwork for new fume hoods.
   - Open storage: 20%, to allow for new walled-off areas.
   - Laboratory support spaces: 25%, to allow for new cold room boxes.
   - Very large classrooms may be divided. Add three heads per room to allow for a new wall.
   - Allow at least a 10 psi safety factor on hydraulic calculations for each building.
5. Electrical spaces must be sprinklered.
6. Locate sprinkler heads at the center of tiles.
7. Plastic pipe is prohibited for use in sprinkler systems.

End of Section
A. Summary

This section contains general design criteria for Heating, Ventilation, and Air Conditioning (HVAC) Systems.

B. System Design and Performance Requirements

1. Air Conditioning Design

   a. There have been several air conditioning projects at Yale University that have been troublesome due to over-design of the fan equipment. Base system sizing on project-specific load calculations and rule-of-thumb cfm/sq ft.

   b. Specify crankcase heaters for all refrigeration compressors, except window units, unless specifically waived by Yale University.

   c. Specify that all refrigeration systems be equipped with the necessary controls for low ambient temperature operation. In most cases, this means 20°F. However, before specifying equipment, discuss with Yale University the need for operation at lower temperatures.

   d. Give special consideration to possible noise problems resulting from the locations of fan equipment, particularly in existing buildings, and of outdoor, air-cooled condensing units.
2. Design Conditions

In the absence of project-specific information, use the design conditions in Table 1 for load calculations.

### Table 1. Design Conditions

<table>
<thead>
<tr>
<th>Space</th>
<th>Summer Occupied</th>
<th>Summer Unoccupied</th>
<th>Winter Occupied</th>
<th>Winter Unoccupied</th>
<th>Winter Recess</th>
<th>Relative Humidity</th>
<th>Air Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offices and conference rooms</td>
<td>73–78°F</td>
<td>HVAC off Temp Uncontrolled</td>
<td>70–73°F</td>
<td>65°F Night Setback</td>
<td>60°F T-Setback</td>
<td>N/A</td>
<td>Summer Unoccupied OFF</td>
</tr>
<tr>
<td>Labs and lab support spaces (as required)</td>
<td>73–78°F</td>
<td>70–80°F Night Setback</td>
<td>70–73°F</td>
<td>65°F Night Setback</td>
<td>60°F T-Setback</td>
<td>50%</td>
<td>Summer/ Winter Unoccupied Setback</td>
</tr>
<tr>
<td>Equipment rooms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animal rooms (each independent)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assembly/DH, etc.</td>
<td>73–78°F</td>
<td>HVAC off Temp Uncontrolled</td>
<td>70–73°F</td>
<td>65°F Night Setback</td>
<td>60°F T-Setback</td>
<td>N/A</td>
<td>Summer Unoccupied OFF</td>
</tr>
<tr>
<td>Classroom</td>
<td>73–78°F</td>
<td>HVAC off Temp Uncontrolled</td>
<td>70–73°F</td>
<td>65°F Night Setback</td>
<td>60°F T-Setback</td>
<td>N/A</td>
<td>Summer Unoccupied OFF</td>
</tr>
<tr>
<td>Dormitory</td>
<td>N/A</td>
<td>N/A</td>
<td>70–73°F</td>
<td>65–68°F Night Setback</td>
<td>60°F T-Setback</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Libraries (common and non-stack areas)</td>
<td>73–78°F</td>
<td>68°F Night Setback</td>
<td>70°F</td>
<td>65°F Night Setback</td>
<td>N/A</td>
<td>30–50%</td>
<td>Summer/ Winter Unoccupied Setback</td>
</tr>
<tr>
<td>Libraries (dedicated stack areas)</td>
<td>70°F</td>
<td>70°F</td>
<td>68°F</td>
<td>68°F</td>
<td>68°F</td>
<td>50%</td>
<td>ON</td>
</tr>
<tr>
<td>Computer rooms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Project-specific</td>
</tr>
<tr>
<td>Museums</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Project-specific</td>
</tr>
</tbody>
</table>
3. **Outside Design Temperatures**

   Base all outside design temperatures for use in equipment sizing and heat transfer calculations on the most current ASHRAE Fundamentals Handbook. The following data is provided for the convenience of the design team:

   a. Winter: 7°F DB (90.0%)
      3°F DB (99.6%)
   
   b. Summer: 82°F DB/74°F WB (2.0%)
      84°F DB/75°F WB (1.0%)
      88°F DB/76°F WB (0.4%)

4. **Equipment Sizing**

   Use the following outside design temperatures for sizing mechanical equipment:

   - Critical or 100% outside air systems: 0.4% DB, 0.4% WB
   - Non-critical systems: 1.0% DB, 1.0% WB
   - Critical air-cooled condensers: 0.4% DB +5°F
   - Non-critical air-cooled condensers: 0.4% DB

5. **Heat Gain and Loss Estimates**

   a. Follow the most current ASHRAE guidelines when estimating heat gains and losses. The design team must conduct an economic life-cycle analysis for insulation values per the most current ASHRAE Fundamentals Handbook. Where it is impractical or impossible to conduct such an analysis, use the following data or code-required values, whichever have the more stringent requirements:

      - Roof: R-30
      - Walls: R-19
      - Floors: R-11
b. The ASHRAE Fundamentals Handbook lists the rates of sensible and latent heat gained from occupants of a conditioned space, as well as the recommended heat gains from selected pieces of equipment. The actual equipment manufacturer's data, if available, takes precedence over the ASHRAE values. Include all office, laboratory, and building system equipment loads in the estimate. Where internal loads cannot be determined exactly (early planning phase), use the loads listed in Table 2.

### Table 2. Internal Heat Loads

<table>
<thead>
<tr>
<th>Space</th>
<th>Occupant Density (Sq Ft/Person)</th>
<th>Lighting (W/Sq Ft)</th>
<th>Misc. Equipment (W/Sq Ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stairs</td>
<td></td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Toilet rooms</td>
<td></td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Telecom data rooms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elevator machine rooms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory storage spaces</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shipping &amp; receiving spaces</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breakout rooms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multi-purpose Rooms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wet laboratories</td>
<td></td>
<td></td>
<td>10.6</td>
</tr>
<tr>
<td>Laboratory workspaces</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory support spaces</td>
<td></td>
<td>20.0 w/equip rooms</td>
<td></td>
</tr>
<tr>
<td>Laboratory equipment rooms</td>
<td></td>
<td>20.0 w/lab support</td>
<td></td>
</tr>
<tr>
<td>Offices</td>
<td></td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>Corridors</td>
<td></td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Conference &amp; seminar rooms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instrumentation rooms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classrooms &amp; lounges</td>
<td></td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>Auditoriums</td>
<td></td>
<td>12.0</td>
<td></td>
</tr>
</tbody>
</table>
6. **Chilled Water System Design Temperatures**

   a. The nominal chilled water supply temperature is 42°F at the central chiller plant. Expect a temperature rise of 1°F to 2°F during distribution.

   b. The chilled water supply temperature is allowed to rise during periods of low load (winter) to as much as 46°F. During these periods, comfort cooling systems are generally able to meet the demand with this higher supply water temperature.

   c. Comfort cooling systems should be designed based on the lowest expected supply water temperature and highest expected load. Cooling systems for process loads that are independent of climatic conditions should be designed based on the highest expected supply water temperature.

   d. Design building chilled water systems for a minimum 18°F rise at full load. There is no maximum limit.

   e. See Section 15625: Water Chillers for chilled water system design criteria.

7. **Heating and Humidification Design**

   a. **Applications**

      (1) Steam is used to transport heat into and indirectly humidify the buildings. Use glycol for pre-heat in mechanical rooms only. Pre-heat coils for 100 percent air make-up units must be steam or glycol-hot water.

      (2) Use hot water heating for reheat, fin-tube radiation, cabinet unit heaters, unit heaters, and similar equipment outside of the mechanical room. Systems should be two-pipe, with utilization of the reverse return arrangement to facilitate system balancing.
b. Terminal Heating

(1) Two types of heating terminal units are generally employed at Yale University: perimeter radiation and terminal reheat. Paragraphs a and b below describe the appropriate system application and operating requirements.

(a) All perimeter spaces must have perimeter radiation systems to compensate for envelope losses. The systems must be two-pipe, fin-tube hot water systems, unless project requirements dictate otherwise. Do not provide animal quarters with perimeter radiation, unless indicated by specific program requirements.

(b) If required by the system design, constant- and variable-volume terminal boxes must have a reheat system. The system must be hot water, unless project requirements dictate otherwise.

(2) Heating, ventilation, and air conditioning is not required in stairs, except to prevent piping installed in the stairway from freezing. Provide cabinet unit heaters or convectors at principal building entrances and landings, as necessary, to maintain a minimum temperature of 50°F.

8. Air Handling System Design

Provide air handling systems to support cooling in the following areas.

a. Offices and Conference Rooms

(1) System Description

(a) Offices and conference rooms must be supported by a variable-volume system.

(b) The system may use return air from office areas or 100 percent outside air. The system shall be capable of delivering 100 percent outside air for free cooling.
(c) The amount of fresh outside air must not drop below 20 cfm per person in the occupied mode. During occupied operation, the system must vary the volume of supply and return or exhaust air to meet the cooling needs of the space. During unoccupied operation, the system must reduce the air volume to some pre-set minimum (two air changes per hour) to maintain the temperature within an acceptable range of ±10°F.

(d) The use of fan coil units is discouraged. Fan coil units should only be used in areas with heavy, concentrated, sensible heat loads.

(2) Pressure Relationships
Design offices, reception areas, and conference rooms to be pressure-positive relative to adjacent areas and pressure-negative with respect to the corridor.

(3) Excess Capacity
Size all system components (AHUs, ducts, diffusers, pumps, heat exchangers) to support 10 percent growth anywhere in the system.

b. Laboratories and Laboratory-Support Areas

(1) System Description
(a) Laboratories and laboratory-support areas must be supported by a variable-volume system.

(b) The system may use return air from office areas or 100 percent outside air. The system shall be capable of delivering 100 percent outside air for free cooling. One hundred percent of the air removed from the laboratory and laboratory-support areas must be exhausted and not be returned to any HVAC system. The exhaust system for laboratory and laboratory-support areas must be separate from other building exhaust systems.
(c) The amount of fresh outside air must not drop below 20 cfm per person in the occupied mode. Nominally, the system must be sized to provide 9 air changes per hour (approximately 2.2 cfm/sq ft) to laboratories and 9 air changes per hour (approximately 3.2 cfm/sq ft) for laboratory-support areas. The exhaust must be 10 percent greater than the supply so that the laboratory and laboratory-support areas are pressure-negative relative to the adjacent area.

(d) During occupied operation, the system must vary the volume of supply and return or exhaust air, above some pre-set minimum (approximately six air changes per hour) to satisfy the hood requirements and to meet the cooling needs of the space. During unoccupied operation, the system must reduce the air volume to some pre-set minimum (approximately two air changes per hour) to satisfy the hood requirements and to maintain the temperature within an acceptable range of ±10°F.

(e) The laboratory supply air system must be interlocked with the fume hood sash position and laboratory general exhaust systems to balance temperature, pressure, and flow requirements. The laboratory controls must be based primarily on air volume to avoid contamination of the laboratory areas.

(f) The use of fan coil units is discouraged. Fan coil units should only be used in areas with heavy, concentrated, sensible heat loads.

(2) Pressure Relationships
Design laboratory and laboratory-support areas to be pressure-negative relative to adjacent areas and the corridor.

(3) Excess Capacity
Size all system components (AHUs, ducts, diffusers, pumps, heat exchangers) to support 25 percent growth anywhere in the system.

(4) Redundancy and Diversity
Equip the supply and exhaust air systems with twin fans, each sized at 65 percent of the exhaust requirements. Fan system diversity may be applied, but must not be greater than 30 percent.
c. **Classrooms**

(1) **System Description**

(a) Classroom areas must be supported by a variable-volume system.

(b) The system may use return air from office areas or 100 percent outside air. The system shall be capable of delivering 100 percent outside air for free cooling.

(c) The amount of fresh outside air must not drop below 20 cfm per person in the occupied mode. During occupied operation, the system must vary the volume of supply and return or exhaust air, above some pre-set minimum (approximately six air changes per hour) to satisfy the cooling needs of the space. During unoccupied operation, the system must reduce the air volume to some pre-set minimum (approximately one air changes per hour) to maintain the temperature within an acceptable range of ±10°F.

(d) The supply air system must be interlocked with the return or exhaust system to balance temperature, pressure, and flow requirements.

(e) The use of fan coil units is discouraged. Fan coil units should only be used in areas with heavy, concentrated, sensible heat loads.

(2) **Pressure Relationships**

Design classroom areas are to be pressure-positive relative to adjacent areas and the corridor.

(3) **Excess Capacity**

Size all system components (AHUs, ducts, diffusers, pumps, heat exchangers) to support 10 percent growth anywhere in the system.
d. Toilet, Locker, and Shower Rooms

(1) System Description
   (a) Toilet, locker, janitor’s closets, and shower room areas must be supported by a constant-volume system.

   (b) The system may use return air from classroom and office areas or use 100 percent outside air, with 100 percent exhaust at all times. The supply air system must be capable of delivering 100 percent outside air for free cooling. The exhaust system for toilet, locker, and shower rooms must be separate from other building exhaust systems.

   (c) The amount of fresh outside air must not drop below 25 cfm per person, based on the maximum projected occupancy.

   (d) Janitor’s closets and similar areas must be exhausted at a rate of not less than 10 air changes per hour.

   (e) The use of fan coil units is discouraged in these areas.

(2) Pressure Relationships
    Design toilet, locker, and shower room areas to be pressure-negative relative to adjacent areas and the corridor.

(3) Excess Capacity
    Size all system components (AHUs, ducts, diffusers, pumps, heat exchangers) to support 10 percent growth anywhere in the system.

e. Residential Colleges

(1) Do not equip dormitories with air conditioning. For offices, bathrooms, cafeterias, and other specific areas within the dormitory, refer to the applicable paragraphs in this document.

(2) Because of heavy traffic and the possibility of damage, do not use fan coil units in hallways. Consider using panel-type radiators.
f. Animal Quarters

(1) System Description
   (a) Animal areas must be supported by a dedicated, constant-volume system.
   (b) The system must be a 100-percent outside air supply system, with 100 percent exhaust at all times. The exhaust system for animal areas must be separate from other building exhaust systems.
   (c) Size all system components and design the system to meet American Association for Accreditation of Laboratory Animal Care (AAALAC) requirements.
   (d) The use of fan coil units is not allowed in these areas.

(2) Pressure Relationships
   Design animal areas to be pressure-negative relative to adjacent areas and the corridor. Pressurize surgery to meet AAALAC requirements.

(3) Excess Capacity
   Size all system components (AHUs, ducts, diffusers, pumps, heat exchangers) to support 20 air changes per hour.

(4) Redundancy and Diversity
   Equip the supply and exhaust air systems with twin fans, each sized at 65 percent of the exhaust requirements. Do not assume any fan system diversity.
g. Cafeterias, Lounges, and Photocopy Rooms

(1) System Description
   (a) Cafeterias, lounges, and photocopy rooms may be supported by either a constant- or variable air volume (VAV) system; a VAV system is preferred.
   (b) The system may use return air from office areas or 100 percent outside air. The system must be capable of delivering 100 percent outside air for free cooling. All of the air removed from these areas must be exhausted. Do not return the air to any other system.
   (c) The amount of fresh outside air in the occupied mode must not drop below 20 cfm per person or code requirements, whichever is greater.
   (d) During occupied operation, the system must vary the volume of supply and return or exhaust air to meet the cooling needs of the space. During unoccupied operation, the system must reduce the air volume to some pre-set minimum (two air changes per hour, or as permitted by code) to maintain the temperature within an acceptable range of ±10°F.
   (e) The use of fan coil units is discouraged. Fan coil units should only be used in areas with heavy, concentrated, sensible heat loads.

(2) Pressure Relationships
   Design cafeterias, lounges, and photocopy rooms to be pressure-negative relative to adjacent areas and the corridor.

(3) Excess Capacity
   Size all system components (AHUs, ducts, diffusers, pumps, heat exchangers) to support 10 percent growth anywhere in the system.

(4) Redundancy and Diversity
   The supply and exhaust air systems may be equipped with a single fan, or twin fans, each sized at 50 percent of the exhaust requirements. Do not assume any fan system diversity.
h. Mechanical, Electrical, and Elevator Equipment Rooms

Equip mechanical, electrical, and elevator equipment rooms with unit heaters to maintain a minimum temperature of 60°F, if they are located in areas where the temperature is expected to fall below 60°F. These rooms must also be equipped with a mechanical ventilation system capable of offsetting heat gain, both internal and external, and maintaining an ambient temperature of not more than 104°F.

i. Garages, Enclosed Driveways, and Loading Platforms

Equip garages, enclosed driveways, and loading platforms with a mechanical ventilation system per NFPA 88. Approximately two-thirds of the exhaust must be taken near the floor or below the loading platform. Consider loading dock heating.

j. Other Spaces

Design all other spaces per appropriate ASHRAE guidelines. The system design must also be consistent with the design philosophy for the types of spaces identified above.

9. Heat Recovery

Heat energy recovery of constantly-operated exhaust air may be done with air-to-air plate-type heat exchangers, heat pipes, desiccant wheels, or coil run-around cycles, for a ducted exhaust of 3000 cfm, or more, for 100-percent outside air units. Design controls for heat recovery systems to avoid defeating any required "free cooling" (economizer cycle) operation. Avoid overheating the outside air during mild or warm weather.
10. Ventilation
   a. Provide ventilation systems that have a minimum of six air changes per hour.
   b. Do not cool the following areas, which must be heated, as necessary, and ventilated with supply and exhaust air:
      - Motor vehicle storage areas
      - Electrical equipment rooms
      - Mechanical equipment rooms
      - Transformer rooms
      - Emergency generator rooms
      - Elevator machine rooms
      - Trash rooms
      - Supply service warehouse areas, except specialized storage requiring mechanical cooling

11. Exhaust Systems
   a. The following areas shall be 100-percent exhausted:
      - Animal research areas
      - Bathing facilities
      - Dark rooms
      - Janitor’s closets
      - Kitchens
      - Laboratories
      - Storage rooms
      - Gas storage rooms
      - Flammable storage rooms
      - Toilet facilities
      - Trash collection areas
      - Confined spaces
b. Provide separate exhaust systems for:
   - Animal wards
   - Autopsy suites
   - Laboratories
   - Each radioisotope hood
   - Each bacteriological cabinet
   - Each perchloric fume hood
   - Each cartwasher or cagewasher
   - Kitchen grease hoods
   - Toilet rooms (Provide separate exhaust when proximity to general exhaust grilles would allow toilet room odors to enter spaces that are normally occupied when the general exhaust fan is off.)
   - Mechanical and electrical rooms
   - Parking garages

12. Pipe Sizing
   Base pipe sizes, pressure loss, and other calculations for circulating water systems on Cameron Hydraulic Data, with C=100 for open (cooling tower) systems and C=130 for closed systems. See Section 15181: Hydronic Piping for recommended velocities in piping.

End of Section
00706
General Electrical Design Conditions

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A. Summary
This section contains definitions, general electrical system design criteria and conditions, and submittal requirements.

B. Definitions

1. Normal Energy Source
The Yale University Co-Gen plant or the United Illuminating Company provide the normal energy source in the Central and Science Area. The normal service provides electrical energy for normal operation of all loads, except those directly connected to an alternate source.
2. Emergency Energy Sources

Those systems that are legally required and classified as emergency by Local, State, Federal, or other codes, or by any government agency having jurisdiction. An emergency source of electrical energy, which upon failure of the normal source, is available for operation of emergency loads, legally required standby loads, and optional standby loads. An emergency source may be used for continuous operation of certain directly-connected loads. In a given building, the emergency source consists of one or more of the following:

a. An alternate utility service from the United Illuminating Company connected to a different United Illuminating Company substation from the normal service and identified by Yale University as the alternate service. The alternate service for the Central and Science Areas may be from Yale University's Co-Gen plant.

b. Central generation facilities located remotely from the protected area, which may consist of turbine- or engine-driven generators at a central location, such as a power plant.

c. Local generation or storage facilities that exist within or near the protected area, which may consist of engine-generator sets, unit equipment, uninterruptible power supplies, or batteries.

3. Interconnected Electrical Power Production

The system consists of one or more electrical power production sources operating in parallel with normal sources through a tie-line monitoring and control system. If the control system is functioning properly, it isolates the fault in one system and leaves the other system carrying the loads without any interruption in service.

4. Normal Electrical Distribution System

Distribution equipment and wiring that controls and conducts electrical energy from the normal source to loads or transfer switches.
5. **Emergency Electrical Distribution System**

   Distribution equipment and wiring that controls and conducts electrical energy from transfer switches to emergency loads. Transfer switches are connected to the normal system and to the alternate system, and are arranged so that upon any failure or outage on the normal system, the load is automatically transferred to the alternate system.

6. **Legally-Required Standby Electrical Distribution System**

   Distribution equipment and wiring that controls and conducts electrical energy from transfer switches to legally-required standby loads and optional standby loads. Transfer switches are connected to the normal system and to the alternate system, and are arranged so that upon any failure or outage on the normal system, the load is automatically transferred to the alternate system.

7. **Optional Standby Electrical Distribution System**

   Distribution equipment and wiring that controls and conducts electrical energy from transfer switches to optional standby loads. Transfer switches are connected to the normal system and to the emergency system, and are arranged so that upon any failure or outage on the normal system, the load is automatically transferred to the emergency system.

8. **Normal Loads**

   All loads other than those described as emergency loads, legally-required standby loads, or optional standby loads.

9. **Emergency Loads**

   Legally-required loads necessary to perform functions essential for safety to human life, in accordance with NEC Article 700. Examples include egress lighting, fire protection, police and fire communications, and critical patient care.

10. **Legally-Required Standby Loads**

    Legally-required loads necessary to perform functions other than those essential for safety to human life, in accordance with NEC Article 701. Examples include smoke removal, essential health care, and pumping of sewage.
11. Optional Standby Loads

All loads identified by Yale University as requiring a constant supply of electricity other than emergency loads and legally-required standby loads, in accordance with NEC Article 702. Examples include certain computer, laboratory, food service, and mechanical equipment.

C. System Design and Performance Requirements

1. Where possible, surface mount panelboards, starters, contactors, control panels, and other similar equipment for such systems such as fire alarm and intrusion detection systems in dedicated electrical rooms so that exposed conduits can be run to such equipment, facilitating future changes to the systems. Electrical rooms must be accessible from common building areas. Where dedicated electrical rooms are not available, locate such equipment in mechanical rooms. When locating such equipment in finished areas is unavoidable, provide an oversized conduit to a junction box located above a hung ceiling or in a closet or other accessible space to facilitate future work. This panel location requirement may be waived for occupancies, such as laboratories, where there is reason to locate panels in the vicinity of the utilization equipment. Size all electrical rooms that contain equipment, such as substations, switchgear, switchboards, panelboards, motor control centers, and fire alarm control panels, with a minimum 50 percent spare area for future additions of equipment.

2. If possible, locate electrical equipment indoors for reasons of personnel safety and to reduce the costs of equipment enclosures. Where utilization equipment is located outdoors, only a non-fused disconnect switch should be provided at the equipment location; controllers should be placed at an appropriate location indoors.

3. Do not obstruct required access to such items as equipment, valves, junction boxes, conduit body covers, and fire detectors, whether new or existing. Allow for the future addition of equipment and access to that equipment. For new work, allow maximum flexibility for future operation and modification of the system. Be familiar with all safety codes, including NEC Article 110: Working Space Access to Spaces.
4. Maintain the fire resistance rating of building assemblies, such as walls, partitions, floors, and ceilings. Fire stop openings for conduits and other electrical work penetrating such assemblies. Panelboards, outlets, and similar items mounted within fire-rated assemblies must be installed in accordance with the listing requirements of such assemblies.

5. Provide ground-fault protection for personnel at all receptacle locations where shock hazards exist. Such locations include, but are not limited to, all areas within six feet of places where water might be present, regardless of occupancy (for example: kitchens, toilet rooms, laboratories, boathouses, pools, garages, mechanical rooms, power plants, crawl spaces, unfinished basements, and roofs and other outdoor locations).

6. Determine equipment functions and circuiting arrangements before preparing construction documents. Ensure that removals do not adversely affect the remaining equipment; extend circuits or provide new circuits, where necessary, to keep the remaining equipment in operation.

7. Plan the project so that outages and downtime are minimized. During the design-development phase, notify the following Yale University agencies when outages will be unavoidable. These agencies are responsible for notifying other affected agencies within the University, as well as affected agencies outside of the University.
   - Utility services and building outages: Yale University Facilities group
   - Fire alarm systems: Yale University Fire Marshal
   - Security systems: Yale University Police
   - Telecommunications system: Yale University Telecommunications Department

8. When the equipment being removed is critical to safety or security, such as grounding systems, lightning protection systems, cathodic protection systems, exitway lighting, emergency lighting, exit signs, exterior lighting, fire alarm systems, and security systems, schedule the work so that existing equipment remains in place and functioning until new equipment is in operation. When this requirement cannot be met, arrange for the provision of temporary services.
D. **Installation Guidelines**

1. Installations must maintain adequate clearances for maintenance and operation of the installed equipment and all adjacent equipment, whether or not related to the work of the project.

2. Where devices are removed but boxes remain, specify suitable cover plates (brushed stainless steel in finished areas).

3. Remove all unused wiring and raceways within project limits back to the last active device, regardless of location. Portions of raceways running through inaccessible spaces may be abandoned if cut back into the structure and patched over. Raceways identified for future use may be abandoned in place if provided with pull wires and identification of all access points.

4. Equipment to be removed and reinstalled must be carefully inspected to determine its condition so that existing defects can be identified on the construction drawings for repair and damage occurring during construction can be distinguished from pre-existing conditions.

5. Clean and service existing equipment before reinstallation. Replace wearing parts, such as contacts and lamps.

6. Installation methods for reinstalled equipment must be equivalent to installation methods required for similar new equipment.