
MIT
BUILDING
SYSTEMS
DESIGN HANDBOOK
VERSION 1.2
MIT Department of
FACILITIES

Contents

MIT Building Systems Design Handbook

This **Building Systems Design Handbook** was developed by MIT for use exclusively by MIT's Department of Facilities and its consultants for new construction and renovation projects. This Handbook sets forth MIT's preferred standards for its own building systems and is not intended to supercede any applicable regulations or codes nor is it intended to stand as a representation of industry standards. MIT makes no express or implied warranties with respect to the fitness for any particular purpose or accuracy of information provided in this Handbook. Users of the Handbook are required to fulfill their legal and professional obligations and to meet all applicable municipal, state, and federal codes and regulations.

Editions:

Revised pages or sections are always identified by the version number located in the lower right corner of each page.

Version **1.1**	October 2001:	The first published draft of MIT's Design Handbook
Version **1.2**	December 2001:	Revisions include only the information on this new page and minor revisions to the Plumbing Section

Massachusetts Institute of Technology

Department of Facilities Building Systems Design Handbook

version 1.2

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DIVISION 1 - General Requirements

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Summary of Key Issues

What is MIT's Building Systems Design Handbook?

The Design Handbook is a document available on CDROM that describes MIT's expectations for all of its construction projects as well as the process for design review. (Formerly known as the "RED Book" or MIT Construction Guidelines)

Who uses this document?

MIT's Project Managers, all design consultants, together with the MIT Stakeholders will use the Handbook as a working template for the ongoing design and review process.

Who are the MIT Stakeholders?

They are the experts in the Engineering, Construction, Maintenance, and Operations Groups within MIT's Department of Facilities. The Stakeholders are full participants in the writing and reviewing of their respective sections of this Building Systems Design Handbook.

What is the role of MIT Stakeholders during the design process?

At each milestone, consultants are required to submit to the Project Manager a completed and signed Design Review Checklist which forms the basis for a formal Design Review Meeting with the stakeholder groups. In addition, a list of Required Engineering Documents appears in the General Requirements section of the Handbook.

Who has the pivotal role in the design & review process?

MIT's Project Managers are responsible for balancing program & budget with the requirements of the Design Handbook. The Project Manager will negotiate with the Stakeholders to solve any conflicts and, if needed, can request a review with the Directors.

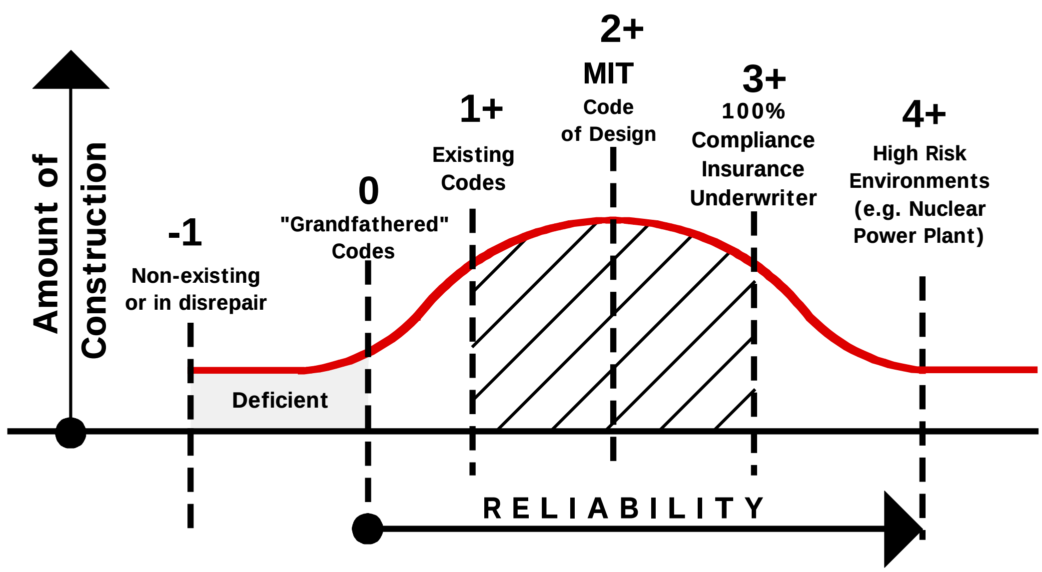
How will this document be updated ?

MIT will notify all active designers as periodic updates of the Handbook become available for distribution on CDROM. Each individual page of the Handbook will include the Version label in the lower right corner so that users can identify immediately which portions have been revised.

Mission Statement:

The MIT Department of Facilities provides the physical environment, utilities, and support services necessary to promote the educational and research activities of the Institute. This is accomplished by the Engineering, Construction, Maintenance, and Operating Groups of Facilities. To ensure quality service to the MIT community, the department provides strong coordination and communications between multi-functional groups and our customers. Training and the development of self-directed work teams promotes a work environment that encourages employee initiative and development. We strive to be a customer services oriented department.

To communicate its needs to designers, the Department of Facilities employs two key mechanisms: an established process for Design Review and a set of Construction Guidelines. The latest version of the Design Guidelines is this electronic DESIGN HANDBOOK---a name that reinforces its importance to designers as the statement of MIT's goals for its construction projects and, in addition, distinguishes this document from its predecessor known as the "RED Book" (MIT Construction Guidelines). The State Building Code is the starting point for MIT's target zone for system performance. The HANDBOOK guides users towards standards of construction appropriate for the many different types of projects at the Institute. Finally, by requiring designers to submit signed Design Review Checklists at each project milestone, the HANDBOOK promotes an ongoing dialogue between design consultants and the experienced Engineering, Construction, Maintenance, and Operating Groups within the Department of Facilities who are referred to in this HANDBOOK as MIT Stakeholders.



Version 1.1 of the new DESIGN HANDBOOK is issued to all MIT Stakeholders, MIT Project Managers and to design consultant teams as a goal to be met by all projects. All consultant teams will be notified of each release; however, each new issue will be an *advisory document* for designers that are already contractually bound to prior versions of the CODE. Projects currently in the construction documents phase or in construction will not be required to adhere to a new version where cost or major redesign would be necessitated. Designers will be notified by MIT's Project Managers if implementation of any new CODE requirements will be mandated for their projects.

(next page)
(return to Key Issues Summary)

The DESIGN HANDBOOK describes MIT's goals for building systems as well as certain special requirements for all construction projects. MIT's Project Managers, design consultants and MIT Stakeholders will use this HANDBOOK as a working template for the ongoing building system design and review process throughout the design and construction project. The Institute's goal is adherence to HANDBOOK provisions as well as to budget and schedule. The new HANDBOOK is available on compact disc in a cross-platform PDF format. Further information about HANDBOOK use and future updates as well as procedures for systematic design review are found below.

Click on the blue highlighted links. To return to beginning of any section, click on the vertical heading in upper right page margin

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1 MIT Special Requirements

MIT Department of Facilities Project Management Documents :

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MIT DEPARTMENT OF FACILITIES

Building Systems Review Matrix:

USER GUIDE

Building System Requirements:	SITE & LANDSCAPE	SHELL & FINISH	INTERIORS	UTILITIES	PLUMBING	HVAC	CENTRAL CONTROL SYSTEMS	ELECTRICAL	FIRE PROTECTION	INFORMATION SYSTEMS
MIT Special Requirements: (overlays)	Landscape Design *Site Utilities* *(See Utilities)* Parking Exterior Lighting Irrigation	Building Envelope Interior Finish Built-ins Equipment Lock Sets & Keying Smoke/Water Mitigation Housekeeping ADA	Furniture Signage & Graphics Room Numbering	Domestic Water Fire Protection Storm Water Sanitary Sewer Duct Banks / Telecom Steam & Condensate Hot Water Chilled Water	Waste Water Drainage Fresh Water Supply	Supply & Make-up Air Exhaust Systems Heating & Cooling	FCS Other Systems	High Voltage Low voltage Fire Alarm Vertical Transportation Metering	Fire Alarm Systems Sprinkler Systems	Space Requirements Transmission Services
	Stakeholder Group	Stakeholder Group	Stakeholder Group	Stakeholder Group	Stakeholder Group	Stakeholder Group	Stakeholder Group	Stakeholder Group	Stakeholder Group	Stakeholder Group
PROJECT MANAGEMENT APPROACH (Stake-holder Group)	DEPARTMENT OF FACILITIES DIRECTORS: CAPITAL PROJECTS / SPACE CHANGES / SPECIAL PROJECTS									
PLANNING / PROGRAM / DESIGN (Stake-holder Group)	MIT PROJECT PLANNER: MIT PROJECT MANAGEMENT MANUAL									
BUDGET / SCHEDULE / CONSTRUCTION (Stake-holder Group)	MIT PROJECT MANAGER: MIT PROJECT MANAGEMENT MANUAL									
CAMPUS FRAMEWORKS (Stake-holder Group)	HISTORIC PRESERVATION / BULDING LINKAGE / LOBBIES & STAIRWAYS / CORRIDORS / SECURITY / ART / SIGNAGE / SPECIAL EVENTS									
LABORATORY SERVICES (Stake-holder Group)	LABORATORY WASTE / VACUUM / PROCESS CHILLED WATER /GASES / COMPRESSED AIR/ PIPING / SPACE REQUIREMENTS									
OPERATIONS (Stake-holder Group)	COMMISSIONING / REPAIR AND MAINTENANCE / OPERATIONS / WARRANTEES / RENEWAL									
ENVIRONMENT HEALTH SAFETY (Stake-holder Group)	HAZARDOUS MAT'LS / WASTE WATER / SOLVENT STORAGE / AIR QUALITY / SUPPLY & EXHAUST AIR / FUME HOODS / RISK MANAGEM'T / MAT'LS HANDLING									
GREEN DESIGN (Stake-holder Group)	SUSTAINABLE SITES / WATER EFFICIENCY / ENERGY CONSERVATION / MATERIALS / INDOOR QUALITY / RISK MANAGEMENT									
SPECIAL OCCUPANCY REQUIREMENTS (Stake-holder Group)	DORMITORIES / LABORATORIES / CLASSROOMS / OFFICES / FOOD SERVICE / ANIMAL FACILITIES / LIST VISUAL ART CENTER / MIT MUSEUM									

Stakeholder Groups and Design Review

The Handbook is organized into 16 divisions loosely based on the CSI format. Sections within the divisions correspond to the MIT Stakeholder groups which consist of individuals within the Department of Facilities who, based on their particular experience and responsibilities at MIT, have contributed to the infomation contained in that division. Each stakeholder assisted in the writing of the sections within the divisions. These same Stakeholders are the principal participants in the ongoing Design Review process that takes place during the design phases of a construction project. See **BUILDING SYSTEMS REVIEW MATRIX.**

MIT Project Managers and the Design Review Process:

The process of Design Review is built around the traditional milestones of the design process. The process may be streamlined at the discretion of MIT's Project Manager as a response to the size of the project; however, no project at MIT should be exempt from the process. At each design milestone (typically Schematic Design, Design Development, and Construction Drawings) the designer will be required to submit to the MIT Project Manager a completed **Design Review Checklist*** found in each of the sections of the Handbook . This checklist, which must be signed and dated by the consultant, will highlight areas in which full compliance has been accomplished as well as areas where the designer may be requesting variances. Project Managers will review the completed checklist and based on its thoroughness will schedule the formal **Design Review Meeting** with the stakeholder groups.

The MIT **Project Manager** has the pivotal role in the design process as the person responsible for balancing a project's program, budget, schedule and Handbook compliance. Since the right balance among these project factors is often difficult to maintain, the Project Manager must work closely with the Stakeholders and with the Directors of the Department of Facilities:

- The Project Manager will work closely with the **Stakeholders** group to seek satisfactory solutions when conflicts arise between strict Handbook compliance and the established project budget or schedule.
- If Handbook/budget/schedule conflicts remain unresolved, the Project Manager candecide to request a review by the group **of Directors**.

The Design Handbook and its checklists augment the extensive procedural information already provided to the Institute's Project Managers in the Department of Facilities Project Management Manual.

Value Engineering and Changes during Construction

Changes from the approved design during construction or after bids are received can undermine the Design Review process and the intent of the Handbook itself. After Construction Drawings are completed, ongoing reviews and changes to the project could be in conflict with prior agreements and understanding of the Stakeholder Groups. For this reason any deviations from the Handbook due to value engineering or construction changes must go through the Project Manager in accordance with the Design Review process.

* See also **Required Engineering Documentation**, a list of specific information including calculations required by the MIT Engineering Stakeholders group for every project.

Overview

The new DESIGN HANDBOOK is created in PDF format in cross-platform software developed by Adobe. This PDF format is easy to open and read with any operating system and computer profile. Although navigation through the document is not difficult, there is basic help available in the PDF reader found in the upper right hand corner of the tool bar (Reader Online Guide).

A few basic elements of the CODE with which users should familiarize themselves:

- The CODE is organized loosely on a CSI format with divergences to better mesh with how MIT's Department of Facilities is organized. Each Division can be accessed through the main index page or through the Division Index pages.

- Links to related items are highlighted throughout the CODE. They are color coded and the curser will change to a hand when dragged over this text. When selected (mouse click) the user will be sent to the connected commentary found in another section.

- Each section of the Code is divided into three parts.

A

Part A: Mission Statement and Design Guidelines

Discussion of the goals and features particular to MIT for each section along with specific design guidelines. The guidelines may be more rigorous than the governing codes or may be peculiar to MIT. The Mission Statement intends guide the designer in reading between the lines and assist in those design areas that are not yet covered in the Handbook.

B

Part B: Special Design Criteria

Material in this part will guide the designer on specific needs and requirements for elements found in the section. Only design criteria that is of interest to MIT in controlling will be listed here.

C

Part C: Products:

All products falling under the section that would likely be used on projects at MIT will be listed here along with MIT's preference for manufacturers (if any) or other pertinent commentary..

- Next are the four principal **Overlays** which provide commentary for that section related to particular topics which are important at MIT: Operations, EHS, Green Design, and Lab Services with an additional category, Institute Spaces and Art, Architecture and Preservation. Throughout the CODE, four symbols appear in margins which which highlight information for the designer within four overlay categories that are important to MIT and not defined by CSI sections. (See next page for **Overlays**)

- Finally, there is a **Design Review Checklist** that will be an important tool for assisting MIT's project manager to be certain that the designer is following the instructions in the Handbook..

Overlays

Operations:

Designation signifies that there are implications to be considered for the designer with respect to MIT repair and maintenance practices. MIT has extensive knowledge about products and approaches to detailing that have worked well in the past or have not performed satisfactorily. The wrench symbol will direct the designer to commentary and perhaps examples of installations for the specific item listed.

EHS: Environmental Health and Safety:
Designation signifies elements that require careful consideration by the designer with respect to environmental and safety issues. These would include items such as fire protection, egress, air quality, and materials used in construction (Material Safety Data Sheets).

Green Design:
Designation signifies an opportunity for the designer to implement environmentally conscious design that typically integrates some aspect of sustainability, energy conservation, or renewable resources. Other features of specifying local materials and non-polluting manufactured and waste products are included in this section.

Lab Services
Designation signifies elements that are particular to laboratory design including MIT's preferred methods for providing the extensive mechanical and electrical services required in teaching and research laboratories.

Navigation

Although users will find their own ways to work their way through the Handbook, a few general guidlenes may initially be helpful:

- Start with the Table of Contents. This page can always be accessed through the “index” button found on every Divisions sub-contents. Any CSI division can be found through the Table of Contents.
- The Division Table of Contents will link to each sub-heading in the Division. Note that the Sections which have been revised for this Version 1.0 will appear in red in the Table of Contents while those sections which have not been updated appear in gray. From within the body of a sub-heading (such as Doors and Windows), click on the side header banner that labels the section to return to the Division Table of Contents by.
- Although not developed for this edition, an index is planned to be located at the end of the Handbook that will direct the user to specific items.
- There is a search function in the PDF reader that will find words of phrases within the document
- The entire code can be printed as a hard copy. Note that there are several hundred pages so the hard copy will be somewhat unwieldy. Again, use of the electronic format is encouraged not only for its convenience but because also because the built-in coordination among sections can be realized only through the hyperlinked jumps.

Updates

The Design Handbook will be updated periodically and MIT will notify all active designers about the update. The update will be distributed by MIT on CDROM. Each update will contain an explanation of which sections have been changed so that hard copies can be amended without re-printing the entire document. Each page of the Handbook will include the version label so that users can identify immediately the most recent update.

The Handbook will be maintained by MIT's Handbook Manager who will be responsible for collecting comments and routing themto the proper stakeholder group for review. Ultimate responsibility for the rewriting and updating of each section will lie with the stakeholder group however the Handbook Manager will implement the change and distribute the new versions.

In addition to successive insertions of updated and re-formatted sections, future versions of the Handbook of Design Practice will contain interactive links that can be activated by a mouse click. In addition to the Overlay symbols which appear in the margins beside relevant text throughout the Handbook , individual sections will be included for each Overlay Group: Operations, Environmental Health and Safety, Green Design, and Laboratory Services. Finally, cross-referencing links will be activated among all sections to reinforce coordination among the disciplines. For example, HVAC equipment requiring new power service will be linked to the Electrical section.

Email any comments or suggestions to Handbook@imai-keller.com.

Acknowledgements

The compilation and writing of the Building Systems Design Handbook was the result of many months of work and the combined efforts of many individuals and firms. Although contributors to the Handbook, both major and minor, could number well into the 100's there were a select few who without their efforts and guidance the Design Handbook would have likely not been a reality at least in its current form. Those individuals and consulting firms are listed below:

MIT Department of Facilities

Victoria Sirianni	**Director Department of Facilities**
Peter Cooper	Assistant Director for Utilities
David Myers	Director, Design and Construction
Paul Curley	Director of Capital Construction
James Wallace	Assistant Director for Operations
Deborah W. Poodry	Director for Capital Project Development

Steering Committee

Hans Antonsson	**Senior Project Manger for Design Handbook**
	Shell & Finish
	Green Design
Talitha Fabricius	Site & Landscape
David Silverman	Interiors
Roger Moore	Utilities
Raul Varela	Plumbing
Lakhan Verma	HVAC
Jack Mannion	Centrol Controls Systems
Bill Wohlfarth	Electrical
Joe Pinciaro	Fire Protection
Brian Shannon	Information Systems
John Hawes	Campus Frameworks
Jack Allen	Lab Services
Stephen Miscowski	Operations
Lou Diberardinis	Environmental Health & Safety

Consultants

Imai / Keller, Inc	**Management & Production of Design Handbook**
	Architecture and Graphic Design
Shooshanian Engineering	HVAC, Controls and Metering
Vanderweil Associates	Plumbing and Utilities
SEA Consultants	Site Utilities
Fay Spofford and Thorndike	Electrical
Fire Pro	Fire Protection
Julie Ferrari	Site and Landscape
Elizabeth Cordero	Green Design

MIT SPECIAL REQUIREMENTS

Required Engineering Documentation

Specific mechanical and electrical system documentation listed below must be submitted at each project milestone.

Required Engineering Documentation: Mechanical

1. Requirements for 100% Schematic Design
   - A. Submit calculations for
     1. Cooling loads
     2. Heating loads
     3. Ventilation loads
     4. Chilled water and steam
     5. Outside air
     6. Total air
     7. Domestic and fire protection water requirements including pressure requirements.
     8. Process water requirements, RODI, equipment cooling
     9. Compressed air, vacuum
     10. Air, water and steam flow diagrams
     11. Selection for major equipment including, but not limited to: AHUs, Pumps, Heat Exchanges, Domestic Water Heaters, PRVs, Process equipment
   - B. Systems considered, *i.e.*:
     1. All air
     2. Combination
     3. Type of heating system
     4. Energy recovery options
     5. Alternate heating and cooling sources
     6. Annual loads projection
     7. Written narrative of systems evaluated and proposed
   - C. Narrative and computations are to be bound.

II. Requirements for 100% Design Development
   - A. All computations are to be completed and updated
   - B. Systems are to be decided; life cycle costing is to be done where required
   - C. Flow diagrams are to be prepared indicating quantities and pipe sizes. Air, water and steam flow diagrams must be complete showing all components, pipe and duct sizes, flow quantities, identification of equipment room locations. Air flow diagram must show total air balance for the building
   - D. Outline specifications are to be prepared; acceptable manufacturers are to be agreed upon
   - E. FCS strategy is to be decided; logic and control diagrams are to be prepared
   - F. Narrative, outline specifications and computations are to be bound

III. Requirements for 100% Construction Documents:
   - A. Update all items required under 100% Design Development
   - B. Any deviations from 100% Design Development are to be identified and documented

Required Engineering Documentation: Electrical

1. Requirements for 100% Schematic design:

(next page)

A. Approximate watt/sf load assumed and why
B. Large motor load list
C. Generator frame size
D. Approximate riser configuration, sizes and distribution philosophy
E. Substation voltage, bus ratings, transformer sizes (may be approximate) and configuration
F. Load profile and voltage rating approximations
    1. Lighting
    2. Power
    3. HVAC
    4. Elevator
    5. Emergency needs
    6. Critical needs
B. All substation breaker frame sizes
C. Initial short circuit current requirements

II. Requirements for 100% Design Development

A. Final load profiles
B. Final equipment sizes
C. Breaker trip settings and sized
D. Final panel schedules
E. Final lighting schedules
F. Final raceway and wire sized
G. Final short circuit analysis
H. Final generator sizes

III. Requirements for 100% Construction Documents
A. Update all items required under 100% Design Development
B. Deviations from 100% Design Development are to be identified and documented

Required Engineering Documentation: *Design Narratives*

A Design Narrative is a summary description of all systems investigated and used in the project. Narratives serve to explain design concepts and to document decisions made during the design process. Like drawings and specifications, narratives are important permanent records of the building design. The drawings and specifications are a record of WHICH systems, materials and components the building contains; narratives should record WHY the systems were chosen—and HOW the systems work. The narrative of each submittal may be based on the previous submittal, but it must be revised and expanded at each stage to reflect the current state of the design.

The Design Narrative includes but is not limited to:

- Description of spaces from the point of view of building functionality *i.e.* offices, computer rooms, dry labs, wet labs, *etc*.
- Description of MEP systems studied and proposed to serve the requirements for the spaces, *i.e.* air handling, heating, cooling, special systems.
- Basis for selection of the proposed system, *i.e.* LCC or other unique criteria.
- General utility application *i.e*. CUP chilled water, steam or other energy source feasible over the life of the building.

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Pre-pricing Design Review Submittal Requirements for Space Changes

Overview

The purpose of the design review submittal is to describe basic design parameters to persons reviewing the project. This review must be completed prior establishing a project budget. The documents developed for pricing must reflect the resolution of issues raised during the review.
The level of detail required for projects will vary and must be established by the MIT Project Manager at the beginning of a project.The following is an outline of the *minimum* level of information to be provided in the submittal.

Project Summary Description

Provide a brief written summary of the project, to include: (attach MEP *Systems Descriptions*, see below)

- ❒ Summary of proposed use(s) of area effected by renovations, type of activities and or research to be carried out in the new space.
- ❒ Number of occupants, schedule of hours of use,
- ❒ Occupancy, Use Group, high hazard activities (as defined by Mass. Building Code).
- ❒ Any exceptional programmatic design criteria must be quantified (e.g. clean room rating, NRC, vibration isolation requirements, strict temperature control, etc.)

Architectural

General: The architectural floor plan defines the proposed layout of the spaces effected within the area of work. The plan will show paths of circulation to and within the effected space and path(s) of egress. Indicate all new and existing partitions and doors, built-in cabinetry and casework, plumbing fixtures, furniture, landscape partitions and any permanent equipment which occupies floor space: hoods, tanks, chemical storage cabinets, etc. Indicate which elements are to be accessible (where applicable) e.g. lab stations, kitchens, etc.

Plans to include:

- Floor Plans:
  - ❒ Locus plan (at small scale), showing the area of work in the context of the entire floor of the building.
  - ❒ Existing room numbers, north arrow, graphic scale
  - ❒ Extent of demolition of existing construction
  - ❒ Wall types, areas of glazing (noting materials and fire resistive construction, STC rating, where required)
  - ❒ New and existing doors, (note sizes and label, where applicable)
  - ❒ Landscape partitions and furniture layout
  - ❒ Casework (where applicable), storage cabinets, fume hoods, glove boxes
  - ❒ Wall-mounted shelving and equipment.
  - ❒ Summary of finishes and materials, *identify products or materials that deviate from the MIT Construction Guidelines*.
  - ❒ Outline specification (required for pricing set) attach to *Project Summary Description.*

- Reflected Ceiling Plan (if required, the RCP at the schematic level may show electrical, mechanical and other items, i.e. lighting, diffusers, sprinklers):
  - ❒ Location of lighting fixtures, ceiling mounted equipment, diffusers, etc.

Pre-pricing Design Review Submittal Requirements for Space Changes

Mechanical

General: The schematic submittal will outline all proposed mechanical systems, how these systems interface with the available building services and how they will be controlled. Any exceptional programmatic design criteria should be quantified (e.g. humidity, particle control, etc., strict temperature control)

System Narrative: attach to *Project Summary Description*

Provide a written summary of the proposed system(s), including their sequence of control and operation. Describe the source of heating, cooling, source of controls, if used. *Highlight procedures, products or materials that deviate from the MIT Construction Guidelines*.

Plans (when required) will indicate:

- ❒ Equipment location and preliminary sizing.
- ❒ Single-line diagrams of duct runs, and preliminary sizing.
- ❒ Piping runs and preliminary sizing.
- ❒ Penetrations of building envelope, sources of outside air
- ❒ Points of connection to existing services: pneumatic control air, drains, gas, chilled water, steam. etc.
- ❒ Demolition of existing services.
- ❒ Physical location of thermostats and control devices

Electrical

General: The schematic submittal will outline all proposed electrical systems, how these systems interface with the available building services.

System Narrative: attach to *Project Summary Description*

Provide a written summary of the type(s) of electrical service proposed, describe lighting types. Any exceptional programmatic requirements should be quantified, e.g. clean power, UPS, emergency back-up). *Highlight procedures, products or materials that deviate from the MIT Construction Guidelines*.

Plans: While dedicated electrical drawings may not be required at this stage, the following items should be resolved or noted. When drawings are required, information noted below may be included on the architectural floor plans.

- ❒ Physical location of new panel, source of power feed
- ❒ Show preliminary location of new power outlets
- ❒ Summary of lighting fixtures types/ lamps/ ballasts
- ❒ Equipment list of items requiring electrical power, operating amperages.
- ❒ Provision for fire alarm, location of panel, (confirm capacity of existing fire alarm system to take additional devices)

· Reflected ceiling plan (when required)
- ❒ Lighting layout, showing types of lighting.

Plumbing / Fire protection

System Narrative: attach to *Project Summary Description*

Provide a written summary of the source and uses of potable and process water systems, gas, compressed air, etc. Any exceptional programmatic services should be quantified, e.g. lab waste neutralization system, exceptional flow rate, etc. *Highlight procedures, products or materials that deviate from the MIT Construction Guidelines*.

Plans: While a dedicated plumbing and fire protection drawing may not be required at this stage, the following items should be resolved or noted:

Plumbing:

- ❒ Show locations of sinks, drains, fixtures and equipment requiring potable/ non potable water
- ❒ Show location and size of back-flow preventers
- ❒ Floor drain location.
- ❒ Equipment cooling requirements (noting flow and frequency of use).
- ❒ Identify where potable and process water systems are separated.
- ❒ Location of point of connection to existing services.

Plumbing Continued

- ❒ Fixture count justification, where toilets are involved.
- ❒ For Labs: obtain from Principal Investigator (PI) list of chemicals that will be used in the lab.

Fire protection:

- ❒ Design criteria of sprinkler system.
- ❒ location of points of connection to existing systems.

End of Document

MIT Department of FACILITIES

Environmental Guidelines for Project Managers

This document is a guide to assist Project Managers to comply with environmental regulations. In conjunction with the Environmental Health & Safety list of Environmental Considerations, these documents will act as a working guide regarding environmental issues. These documents should not be used as substitutes for contacting the appropriate environmental personnel.

The Project Manager (PM) is responsible for addressing environmental issues in design and construction. The Environmental Manager (EM) is the point-of-contact regarding environmental issues. The role of the EM is to provide information and/or for referrals.

MIT personnel have established relationships with regulators over time and can provide valuable advice to Project Managers. Project Managers, architects and consultants working for MIT should consult with the EM before contacting regulators. In many cases, MIT personnel will be the direct contact to the regulators.

For emergencies such as spills, unexpected odors, oily sheen, or buried tank, call (25)3-1500 and report a release to the environment. This will activate the Environmental, Health and Safety Team.

The MIT Department of Facilities Environmental Team contacts for design and construction projects are:

Jennifer Combs
Department of Facilities
Environmental Manager
NE20-277
3-7671
jcombs@plant.mit.edu

Vaughn Crayton
Department of Facilities
Environmental Coordinator
NE20-277
3-5898
vcrayton@plant.mit.edu

Soil and groundwater

MIT soils are generally comprised of urban fill, with pockets of contamination due to the type of fill used or resulting from industrial activity in this area. Therefore, projects involving soil disturbance will require compliance with Massachusetts Contingency Plan (MCP21E) regulations. The usual contaminants found on campus are lead, residuals of coal ash, and byproducts of petroleum products. Other contaminants have been found in campus soils as well.

Whenever a project involves displacing soil on campus, there are several requirements to take into consideration:

1. Any project involving digging must be reviewed in advance by the Environmental Coordinator (EC) to identify underground utility issues.

2. If a project involves digging and back filling using the excavated soil, there are usually no special environmental concerns. However, if a contractor discovers an unusual odor or color or an underground tank, sump, or drum, please call the Operations Center at 3-1500 and ask for the on-call Environmental, Health and Safety person. Also please call the Environmental Manager (EM) at 3-7671. Special arrangements may be needed to analyze the soil for contaminants.

3. If a project involves digging and then disposing of excess soil off-site, please consult with the EM in advance. If possible, pre-characterize the soil in advance of construction but within one year of removal. This will allow time to address soil removal issues but not trigger additional regulatory burdens. For scheduling purposes, keep in mind that arrangements to remove contaminated soils to appropriate landfills or recycling facilities may take up to six weeks to process.

   NOTE: If contaminated soil has to be stockpiled off-site, it cannot be transported along a public road without the proper Bill of Lading or manifest on hand.

4. Before beginning an environmental investigation, the PM should consult with the EM about the choice of the environmental consulting firm for the project and to review proposals. The following are MIT's preferred soils and geotechnical consultants:

   GZA Geo Environmental, Inc.
   One Edgewater Drive
   Norwood, MA 02062
   (781) 278-5710
   Lawrence Feldman, Ph.D., LSP

   Haley and Aldrich
   65 Medford Street, Suite 2000
   Boston, MA 02129-1400
   (617) 886-7400
   Keith Johnson, PE, LSP

   McPhail Associates
   30 Norfolk Street
   Cambridge, MA 02139
   (617) 868-1420
   Ambrose Donovan, PE, LSP

   Camp Dresser & McKee, Inc.
   50 Hampshire Street
   Cambridge, MA 02139
   (617) 452-6000
   William R. Swanson, PE, LSP

5. MIT has retained the services of Alpha Analytical for laboratory analyses. Please inform the consultant to utilize their services. Alpha Analytical will directly bill MIT.

6. It is helpful to hire the environmental firm for "turnkey" work, requiring them to keep you informed of pending deadlines.

   NOTE: Once a site has been listed with the state, the MCP21E timeline begins, and does not stop even if the project is delayed. Funding sources will be required to keep the Institute in compliance.

7. If the soil and/or groundwater conditions are such that they may trigger MCP21E notification please notify the Facilities EM. Most of our sites fall under the 120-day notification requirement to the Department of Environmental Protection (DEP). However, if there is any question or chance that the site may fall under the 72-hour or 2-hour notification requirements, the EM and MIT’s in-house Licensed Site Professional (LSP) – Jim Curtis, ext. 2-2508 –should be notified immediately. Many situations have different interpretations and the reporting should be made by determinations with MIT’s LSP and the environmental consultant’s LSP.

8. The EM should review drafts of all proposals, reports and correspondence with the DEP before they are submitted. Please allot time for this. Copies of final submittals should be sent to the EM in NE20-277 for central record keeping.

9. The majority of our contaminated soil can be removed under a Bill of Lading, which can be signed by the PM. Soil with higher concentrations of contaminants may have to be removed under a hazardous waste manifest. Someone from the Environmental Management Office must sign manifests. All manifests must use MIT’s EPA number – MAD001425594 (for NW62 use MAD985268309). Please call the Environmental Management Office at 452-3666 to obtain a signature. Whenever possible, please try to arrange this in advance. In an emergency situation the EM can sign manifests.

10. Some soils can be treated on site and removed as non-hazardous (i.e. soils failing TCLP for lead). Please consider this option.

11. If the contaminated soil must be stockpiled, it must be stockpiled on site and cannot be combined with other stockpiled soil. The EM should be aware of this pile and the eventual plans for disposal. The stockpiled soil should be placed on an impervious surface or polyethylene sheeting (6 mil or greater) and covered with polyethylene sheeting. The covering should be inspected and maintained by the contractor for the duration of the project.

12. Before installing groundwater monitoring wells or taking soil borings, please review existing data from previous projects in the area. Information is on file with the EM. Review the proposed locations with the EC in advance for dig-safe issues, as special vacuum extraction procedures may be required. Forward site maps of wells in CAD form to the EM.

13. Once the environmental remediation is complete, the PM should close out the groundwater monitoring wells. Generally, this means filling with concrete, removing the covers and informing the EM.

14. In some cases environmental remediation may be required after project completion. The Facilities EM may become the Project Manager for the remainder of the remediation. This will be determined between the EM and the PM.

Questions related to these issues should be directed to the Department of Facilities Environmental Manager, Jennifer Combs, at 3-7671.

Wastewater

1. The EC must review any project affecting the campus MWRA Sewerage Discharge Permit or City of Cambridge Sewer Permit at conceptual design and during the design review process. Items that must be reviewed include:

    - A change in the volume or characteristics of the wastewater
    - Laboratory renovations or construction
    - Cage washers
    - Wastewater treatment systems
    - Water Pretreatment
    - DI/RO water system
    - Sewer tie ins
    - Photo labs
    - Polishing equipment
    - Snow melting equipment
    - Kitchen renovations or construction
    - Grease traps
    - Oil/water separators

2. The MWRA requires a 30-day notice from the EC before MIT is allowed to take any action that may change the nature of discharge. Action may be considered planning, not just installation.

3. The PM should verify that city water lines have been disinfected per City of Cambridge requirements. Records should be forward to the EC for record keeping.

Questions related to these issues should be directed to the Department of Facilities Environmental Coordinator, Vaughn Crayton, at 3-5898.

De-watering and stormwater

1. The Project Manager should have construction de-watering permits (DPW, NPDES and MWRA) available on site. Copies should be sent to the EC for record keeping.

2. Storm drains should be protected from silt and debris. Storm drains should be cleaned after construction if needed. The contractor should submit a written plan to the PM describing the silt control method to be used.

3. A stormwater control (SPCC) permit is required for construction projects that disturb more than one acre.

4. Pavement and the stormwater system should be protected from oil and gas leaks from construction vehicles and equipment.

Questions related to these issues should be directed to Vaughn Crayton at 3-5898.

Construction Activity

Construction activity brings with it a variety of Environmental Health & Safety issues. EH&S specifications should be strictly adhered to by the contractor and subcontractors.

1. Trucks may not idle near air intakes. If necessary, Operations (3-1500) may be able to schedule turning off the intake fans.

2. Construction dust reduces air quality and should be controlled by the contractor. A written dust control and mitigation plan may be appropriate depending on the size of the project.

Questions related to these issues should be directed to Jennifer Combs at 3-7671.

Hazardous Materials

1. Asbestos waste forms should be sent to Jackie Leahy of EMO in MIT Room 7-206.

2. A member of the Environmental Management Office must sign hazardous waste manifests. Please contact them in advance at 452-3666 to coordinate.

3. Hazardous waste must be properly stored and labeled. Additional information can be obtained from the EM.

Questions related to these issues should be directed to Jennifer Combs at 3-7671.

Other

There are many other areas that have environmental or permitting applications. The following is a sample of issues to consider.

1. Will an emergency generator be installed in this space?

2. Will a gas or oil burner be installed?

3. Will an underground or above ground storage tank be installed?

Questions related to these issues should be directed to Jennifer Combs at 3-7671.

GREEN DESIGN

MIT Department of FACILITIES

BUILDING SYSTEMS

DESIGN HANDBOOK

ver. 1.1

Mission Statement

MIT has a commitment to integrate environmentally responsible development practices into its building program. These practices, defined as sustainability, imply well-designed buildings and site environments that are healthy to occupy, have minimal undesirable impact upon the environment, are effective in the use of natural resources, and are economical and durable. By employing these practices, MIT will demonstrate that exceptional sustainability levels can be achieved within realistic parameters by balancing initial costs, life cycle costs, and environmental impacts. The Institute will achieve and maintain these principles through the broad participation of all persons involved in planning, design, construction, operation, renovation, and demolition of campus buildings and landscape. To implement this policy, MIT has developed *LEED-Plus*--green design guidelines that are largely based upon the US Green Building Council Leadership in Energy and Environmental Design (LEED$_{TM}$ 2.0) methodology. We believe that sustainable development concepts, as applied to design and construction, can have a huge impact on the Institutes economic well being, as well as the health of the students, faculty, staff and visitors of the campus. Wherever possible, MIT will make environmental strategies explicit so as to communicate an emerging emphasis for these considerations. Included among MIT's important long-range goals:

Conserve energy, seeking continuous reductions in our *per capita* energy consumption
Reduce campus air emissions, including those from transportation, of green house gasses and regulated pollutants
Reduce material and resource consumption including office and laboratory supplies and water
Increase the recycling and conservation of materials
Increase the use of recycled-content products
Reduce the volume and toxicity of our hazardous waste streams
Improve our indoor environment, including both the indoor air quality and the comfort and productivity of our work and living spaces, by considering sustainability in our design, operations and maintenance policies
Improve the urban environment, including landscape quality and the site and pedestrian environment
Educate our students in sustainable concepts so that they may apply them in their professions
Support community-wide and regional sustainability efforts

Top Ten List of Common High Performance Design Issues

1) Consider energy efficient design concepts such as natural daylighting and ventilation strategies. Optimize the design for effective use of space.
2) Avoid ozone-depleting products and materials.
3) Design the building for future adaptability and reuse.
4) Select materials that are have a low environmental impact, and are resource efficient, durable and recyclable. Design so that it is easy for the occupants to recycle.
5) Design with the health and comfort of the occupant in mind.
6) Minimize and recycle construction and demolition waste.
7) Employ sustainable landscape practices.
8) Consider the renovatation of older buildings instead of demolition.
9) Design multi-use facilities to encourage the interaction between the campus and the community.
10) Encourage an interactive process that allows for the incorporation of high-performance design strategies at all phases of planning, design and construction.

Introduction

Buildings are an integration of many interdependent systems: structure, envelope, lighting, mechanical, HVAC, materials, plumbing, telecommunications, security, etc. How these systems relate and work together is key in understanding and designing a green building. Sustainable architecture means looking at the building process and design in a holistic manner because each design decision affects another. For example, the choice early in schematic design to use natural ventilation and daylighting will affect the capacity of the HVAC unit specified. In turn, these decisions all have local, global, natural resource, indoor environmental quality, and cost implications. Therefore, the design team should address environmental design concepts from the start of the project. To that end, MIT requires all new construction and renovation projects to comply with the following Design Requirements. This document is intended for the project team to use as a reference guide during the planning, design and construction phases.

The current version of MIT's Code of Design will require the designer to satisfy the conditions of 50% of LEED rating points on all new construction and renovation projects, or a minimum of 33 out of a total of 69. Version 2.0 will include additional MIT rating points that are unique to the climate and conditions of the Institute. The additional requirements will outline specific environmental target goals and campus priorities. The requirements are performance-based, therefore the design team has flexibility in their approach to earn points. The document is organized into the categories of Sustainable Sites, Water Efficiency, Materials and Resources, Energy and Atmosphere, Indoor Environmental Quality, and Innovation and Design Process. Within each of these categories, a brief description of the condition to satisfy the requirements of the point is listed. (For further information regarding strategies and technologies, see http://www.usgbc.org) Many of these requirements are based on established building codes. The intent is for the project to acheive a combination of points in each of the six categories. Due to the location of the MIT campus, every project will automatically attain five LEED Sustainable Sites points.

The designer is responsible for completing a Design Review Checklist, (found at the end of this section) at the Schematic, Design Developement and Construction Documents phases. The Checklist, signed and dated, will be submitted to the MIT Project Manager prior to the Design Review meeting. After the Project Manager has reviewed the Checklist, a meeting will be held with the Green Design Stakeholder Group for review and comments. The Green Design Stakeholder Group is available for questions throughout the design process.

MIT understands there may be additional first-costs associated with some of the technologies and strategies necessary for compliance with the MIT Design Requirements. Alternatively, innovative green design strategies may also have long-term cost savings to the Institute. Therefore, a cost-benefit analysis should be conducted so that the Stakeholder Group can assess the value of the design decision.

MIT Design Requirements

	Sustainable Sites	LEED
	Erosion and Sedimentation Control Control erosion to reduce negative impacts on water and air quality.	
X	**Credit Requirements** Design to a site sediment and erosion control plan that conforms to best management practices in the EPA's Storm Water Management for Construction Activities, EPA Document No. EPA-832-R-92-005, Chapter 3, OR local Erosion and Sedimentation Control standards and codes, whichever is more stringent. The plan shall meet the following objectives: - Prevent loss of soil during construction by storm water run-off and/or wind erosion, including protecting topsoil by stock-piling for reuse. - Prevent sedimentation of storm sewer or receiving streams and/or air pollution with dust and particulate matter.	R
	Site Selection Avoid development of inappropriate sites and reduce the environmental impact from the location of a building on a site.	
X	**Credit Requirements** Do not develop buildings on portions of sites that meet any one of the following criteria: -Prime farmland as defined by the American Farmland Trust -Land whose elevation is lower than 5 feet above the elevation of the 100-year flood as defined by FEMA -Land which provides habitat for any species on the Federal or State threatened or endangered list -Within 100 feet of any wetland as defined by 40 CFR, Parts 230-233 and Part 22, OR as defined by local or state rule or law, whichever is more stringent -Land which prior to acquisition for the project was public parkland, unless land of equal or greater value as parkland is accepted in trade by the public landowner (Park Authority projects are exempt)	1
	Urban Redevelopment Channel development to urban areas with existing infrastructures, protecting greenfields and preserving habitat and natural resources.	
X	**Credit Requirements** Increase localized density to conform to existing or desired density goals by utilizing sites that are located within an existing minimum development density of 60,000 square feet per acre (2 story downtown development)	1

MIT Design Requirements

	Sustainable Sites	LEED
	Brownfield Redevelopment Rehabilitate damaged sites where development is complicated by real or perceived environmental contamination, reducing pressure on undeveloped land.	
X	**Credit Requirements** Develop on a site classified as a Brownfield and provide remediation as required by EPA's Sustainable Redevelopment of Brownfields Program requirements.	1
	Alternative Transportation Reduce pollution and land development impacts from automobile use.	
X	**Credit Requirements** Locate building within ½ **mile** of a commuter rail, light rail or subway station or ¼ **mile** of 2 or more bus lines	1
	Credit Requirements Provide suitable means for securing bicycles, with convenient changing/ shower facilities for use by cyclists, for **5%** or more of building occupants	1
	Credit Requirements Install alternative-fuel refueling station(s) for **3%** of the total vehicle parking capacity of the site. Liquid or gaseous fueling facilities must be separately ventilated or located outdoors	1
	Credit Requirements Size parking capacity not to exceed minimum local zoning requirements AND provide preferred parking for carpools or van pools capable of serving **5%** of the building occupants, OR, add no new parking for rehabilitation projects AND provide preferred parking for carpools or van pools capable of serving **5%** of the building occupants.	1

MIT Design Requirements

Sustainable Sites	LEED
Reduced Site Disturbance Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.	
Credit Requirements On greenfield sites, limit site disturbance including earthwork and clearing of vegetation to **40 feet** beyond the building perimeter, **5 feet** beyond primary roadway curbs, walkways, and main utility branch trenches, and **25 feet** beyond pervious paving areas that require additional staging areas in order to limit compaction in the paved area; OR, on previously developed sites, restore a minimum of **50%** of the remaining open area by planting native or adapted vegetation.	1
Credit Requirements Reduce the development footprint (including building, access roads and parking) to exceed the local zoning's open space requirement for the site by **25**%.	1
Stormwater Management Limit disruption of natural water flows by minimizing stormwater runoff, increasing on-site infiltration and reducing contaminants.	
Credit Requirements **No net increase** in the rate and quantity of stormwater run-off from existing to developed conditions; OR, if existing imperviousness is greater than **50%,** implement a stormwater management plan that results in a **25%** decrease in the rate and quantity of stormwater runoff.	1
Credit Requirements Treatment systems designed to remove **80%** of the average annual post development total suspended solids (TSS), and **40%** of the average annual post development total phosphorous (TP), by implementing Best Management Practices (BMPs) outlined in EPA's Guidance Specifying Management Measures for Sources of Non-point Pollution in Coastal Waters (EPA 840-B-92-002 1/93).	1

Sustainable Sites	LEED
Landscape and Exterior Design to Reduce Heat Islands Reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat.	
Credit Requirements Provide shade (within 5 years) on at least **30%** of non-roof impervious surface on the site, including parking lots, walk-ways, plazas, etc., OR, use light-colored/high-albedo materials (reflectance of at least 0.3) for **30%** of the site's non-roof impervious surfaces, OR place a minimum of **50%** of parking space underground OR use open-grid pavement system (net impervious area of LESS than 50%) for a minimum of **50%** of the parking lot area.	1
Credit Requirements Use ENERGY STAR Roof-compliant, high-reflectance AND high emissivity roofing (initial reflectance of at least 0.65 and three-year-aged reflectance of **at least 0.5** when tested in accordance with ASTM E903 and emissivity of **at least 0.9** when tested in accordance with ASTM 408) for a minimum of **75%** of the roof surface; OR, install a "green" (vegetated) roof for at least **50%** of the roof area.	1
Light Pollution Reduction Eliminate light trespass from the building site, improve night sky access, and reduce development impact on nocturnal environments.	
Credit Requirements Do not exceed Illuminating Engineering Society of North America (IESNA) footcandle level requirements as stated in the Recommended Practice Manual: Lighting for Exterior Environments, AND design interior and exterior lighting such that zero direct-beam illumination leaves the building site.	1
Sustainable Sites Score 14 Possible LEED Points	**Total:**

MIT Design Requirements

Water Efficiency	LEED
Water Efficient Landscaping Limit or eliminate the use of potable water for landscape irrigation.	
Credit Requirements Use high efficiency irrigation technology, OR, use captured rain or recycled site water, to reduce potable water consumption for irrigation by **50%** over conventional means.	1
Credit Requirements Use only captured rain or recycled site water for an additional **50%** reduction **(100% total reduction)** of potable water for site irrigation needs, OR, do not install permanent landscape irrigation systems.	1
Innovative Wastewater Technologies Reduce the generation of wastewater and potable water demand, while increasing the local aquifer recharge.	
Credit Requirements Reduce the use of municipally provided potable water for building sewage conveyance by a minimum of **50%,** OR, treat **100%** of wastewater on site to tertiary standards.	1
Water Use Reduction Maximize water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.	
Credit Requirements Employ strategies that in aggregate use **20%** less water than the water use baseline calculated for the building (not including irrigation) after meeting Energy Policy Act of 1992 fixture performance requirements.	1
Credit Requirements Exceed the potable water use reduction by an additional **10%** (**30%** total efficiency increase).	1
Sustainable Sites Score 5 Possible LEED Points	**Total:**

MIT Design Requirements

	Energy & Atmosphere	LEED
	Fundamental Building Systems Commissioning Verify and ensure that fundamental building elements and systems are designed, installed and calibrated to operate as intended.	
X	**Credit Requirements** Implement the following fundamental best practice commissioning procedures: -Engage a commissioning authority -Review design intent and basis of design documentation -Include commissioning requirements in the construction documents -Develop and utilize a commissioning plan -Verify installation, functional performance, training and documentation -Complete a commissioning report	R
	Minimal Energy Performance Establish the minimum level of energy efficiency for the base building and systems.	
X	**Credit Requirements** Design to meet building energy efficiency and performance as required by ASHRAE/IESNA 90.1-1999 or the local energy code, whichever is the more stringent.	R
	CFC Reduction in HVAC&R Equipment Reduce ozone depletion.	
X	**Credit Requirements** Zero use of CFC-based refrigerants in new building HVAC&R base building systems. When reusing existing base building HVAC equipment, complete a comprehensive CFC phaseout conversion.	R
	Optimize Energy Performance Achieve increasing levels of energy performance above the prerequisite standard to reduce environmental impacts associated with excessive energy use.	
	Credit Requirements Reduce design energy cost compared to the energy cost budget for regulated energy components described in the requirements of ASHRAE/IESNA Standard 90.1-1999, as demonstrated by a whole building simulation using the Energy Cost Budget Method described in Section 11: Reduce design energy costs in New Buildings **- 20%** Existing Buildings **- 10%** . Regulated energy components include HVAC systems, building envelope, service hot water systems, lighting and other regulated systems as defined by ASHRAE.	2

MIT Design Requirements

Energy & Atmosphere

	Energy & Atmosphere	LEED
	Credit Requirements Reduce design energy cost compared to the energy cost budget for regulated energy components described in the requirements of ASHRAE/IESNA Standard 90.1-1999, as demonstrated by a whole building simulation using the Energy Cost Budget Method described in Section 11: Reduce design energy costs in New Buildings - **30%** Existing Buildings - **20%** . Regulated energy components include HVAC systems, building envelope, service hot water systems, lighting and other regulated systems as defined by ASHRAE.	2
	Credit Requirements Reduce design energy cost compared to the energy cost budget for regulated energy components described in the requirements of ASHRAE/IESNA Standard 90.1-1999, as demonstrated by a whole building simulation using the Energy Cost Budget Method described in Section 11: Reduce design energy costs in New Buildings - **40%** Existing Buildings **- 30%** . Regulated energy components include HVAC systems, building envelope, service hot water systems, lighting and other regulated systems as defined by ASHRAE.	2
	Credit Requirements Reduce design energy cost compared to the energy cost budget for regulated energy components described in the requirements of ASHRAE/IESNA Standard 90.1-1999, as demonstrated by a whole building simulation using the Energy Cost Budget Method described in Section 11: Reduce design energy costs in New Buildings - **50%** Existing Buildings - **40%** . Regulated energy components include HVAC systems, building envelope, service hot water systems, lighting and other regulated systems as defined by ASHRAE.	2
	Credit Requirements Reduce design energy cost compared to the energy cost budget for regulated energy components described in the requirements of ASHRAE/IESNA Standard 90.1-1999, as demonstrated by a whole building simulation using the Energy Cost Budget Method described in Section 11: Reduce design energy costs in New Buildings - **60%** Existing Buildings - **50%** . Regulated energy components include HVAC systems, building envelope, service hot water systems, lighting and other regulated systems as defined by ASHRAE.	2

MIT Design Requirements

Energy & Atmosphere	LEED
Renewable Energy Encourage and recognize increasing levels of self-supply through renewable technologies to reduce environmental impacts associated with fossil fuel energy use.	
Credit Requirements Supply a net fraction of the building's total energy use (as expressed as a fraction of annual energy cost) through the use of on-site renewable energy systems. **5%** Total Energy Load Cost in Renewables	1
Credit Requirements Supply a net fraction of the building's total energy use (as expressed as a fraction of annual energy cost) through the use of on-site renewable energy systems. **10%** Total Energy Load Cost in Renewables	1
Credit Requirements Supply a net fraction of the building's total energy use (as expressed as a fraction of annual energy cost) through the use of on-site renewable energy systems. **20%** Total Energy Load Cost in Renewables	1
Additional Commissioning Verify and ensure that the entire building is designed, constructed, and calibrated to operate as intended.	
Credit Requirements In addition to the Fundamental Building Commissioning prerequisite, implement the following additional commissioning tasks: 1. Conduct a focused review of the design prior to the construction documents phase. 2. Conduct a focused review of the Construction Documents when close to completion. 3. Conduct a selective review of contractor submittals of commissioned equipment. (The above three reviews must be performed by a firm other than the designer.) 4. Develop a recommissioning management manual. 5. Have a contract in place	1
Ozone Depletion Reduce ozone depletion and support early compliance with the Montreal Protocol.	

MIT Design Requirements

Energy & Atmosphere

Energy & Atmosphere	LEED
Credit Requirements Install base building level HVAC and refrigeration equipment and fire suppression systems that do not contain HCFC's or Halon.	1
Measurement & Verification Provide for the ongoing accountability and optimization of building energy and water consumption performance over time.	
Credit Requirements Comply with the long term continuous measurement of performance as stated in Option B: Methods by Technology of the US DOE's International Performance Measurement and Verification Protocol (IPMVP) for the following: -Lighting systems and controls -Constant and variable motor loads -Variable frequency drive (VFD) operation -Chiller efficiency at variable loads (kW/ton) -Cooling load -Air and water economizer and heat recovery cycles -Air distribution static pressures and ventilation air volumes -Boiler efficiencies -Building specific process energy efficiency systems and equip-ment -Indoor water risers and outdoor irrigation systems	1
Green Power Encourage the development and use of grid-source energy technologies on a net zero pollution basis.	
Credit Requirements Engage in a two year contract to purchase power generated from renewable sources that meet the Center for Resource Solutions (CRS) Green products certification requirements.	1

Energy & Atmosphere Score 17 Possible LEED Points	**Total:**

MIT Design Requirements

Materials & Resources	LEED
Storage and Collection of Recyclables Facilitate the reduction of waste generated by building occupants that is hauled to and disposed of in landfills.	
Credit Requirements Provide an easily accessible area that serves the entire building and is dedicated to the separation, collection and storage of materials for recycling including (at a minimum) paper, glass, plastics, and metals.	R
Building Reuse Extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste, and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.	
Credit Requirements Reuse large portions of existing structures during renovation or redevelop-ment projects: Maintain at least **75%** of existing building structure and shell (exterior skin and framing excluding window assemblies).	1
Credit Requirements Reuse large portions of existing structures during renovation or redevelop-ment projects: Maintain an additional **25%** (**100%** total) of existing building structure and shell (exterior skin and framing excluding win-dow assemblies).	1
Credit Requirements Reuse large portions of existing structures during renovation or redevelop-ment projects: Maintain **100%** of existing building structure and shell AND **50%** non-shell (walls, floor coverings, and ceiling systems)	1
Construction Waste Management Divert construction, demolition, and land clearing debris from landfill disposal. Redirect recyclable material back to the manufacturing process.	
Credit Requirements Develop and implement a waste management plan, quantifying material diversion by weight. (Remember that salvage may include the donation of materials to charitable organizations such as Habitat for Humanity.) Recycle and/or salvage at least **50%** (by weight) of construction, demolition, and land clearing waste.	1

MIT Design Requirements

Materials & Resources	LEED
Credit Requirements Develop and implement a waste management plan, quantifying material diversion by weight. Recycle and/or salvage an additional **25%** (**75%** total by weight) of the construction, demolition, and land clearing debris	1
Resource Reuse Extend the life cycle of targeted building materials by reducing environmental impacts related to materials manufacturing and transport.	
Credit Requirements Specify salvaged or refurbished materials for **5%** of building materials.	1
Credit Requirements Specify salvaged or refurbished materials for **10%** of building materials.	1
Recycled Content Increase demand for building products that have incorporated recycled content materials, therefore reducing the impacts resulting from the extraction of new materials.	
Credit Requirements Specify a minimum of **25%** of building materials that contain in aggregate, a minimum weighted average of **20%** post-con-sumer recycled content mate-rial, OR, a minimum weighted average **40%** post-industrial recycled content material.	1
Credit Requirements Specify an additional **25%** (**50%** total) of building materials that contain in aggregate, a minimum weighted average of **20%** post-consumer recycled content material, OR, a minimum weighted average of **40%** post-industrial recycled content material.	1
Local/Regional Materials Increase demand for building products that are manufactured locally, thereby reducing the environmental impacts resulting from their transportation and supporting the local economy.	
Credit Requirements Specify a minimum of **20%** of building materials that are manufactured regionally within a radius of 500 miles.	1

Materials & Resources	LEED
Credit Requirements Of these regionally manufactured materials, specify a minimum of **50%** that are extracted, harvested, or recovered within **500 miles**.	1
Rapidly Renewable Materials Reduce the use and depletion of finite raw, and long-cycle renewable materials by replacing them with rapidly renewable materials.	
Credit Requirements Specify rapidly renewable building materials for **5%** of total building materials.	1
Certified Wood Encourage environmentally responsible forest management.	
Credit Requirements Use a minimum of **50%** of wood-based materials certified in accordance with the Forest Stewardship Council Guidelines for wood building components including but not limited to structural framing and general dimensional framing, flooring, finishes, furnishings, and non-rented temporary construction applications such as bracing, concrete form work and pedestrian barriers.	1

Materials & Resources Score 13 Possible LEED Points	**Total:**

MIT Design Requirements

Indoor Environmental Quality	LEED
Minimum IAQ Performance Establish minimum indoor air quality (IAQ) performance to prevent the development of indoor air quality problems in buildings, maintaining the health and well being of the occupants.	
Credit Requirements Meet the minimum requirements of voluntary consensus standard ASHRAE 62-1999, Ventilation for Acceptable Indoor Air Quality and approved Addenda.	R
Environmental Tobacco Smoke Control Prevent exposure of building occupants and systems to Environmental Tobacco Smoke (ETS).	
Credit Requirements Zero exposure of nonsmokers to ETS by prohibition of smoking in the building, OR, provide a designated smoking room designed to effectively contain, capture and remove ETS from the building. At a minimum, the smoking room shall be directly exhausted to the outdoors with no recirculation of ETS-containing air to the nonsmoking area of the building, enclosed with impermeable structural deck-to-deck partitions and operated at a negative pressure compared with the surrounding spaces of at least 7 Pa (0.03 inches of water gauge). Performance of smoking rooms shall be verified using tracer gas testing methods as described in the ASHRAE Standard 129-1997. Acceptable exposure in nonsmoking areas is defined as less than 1% of the tracer gas concentration in the smoking room detectable in the adjoining nonsmoking areas. Smoking room testing as described in the ASHRAE Standard 129-1997 is required in the contract documents and critical smoking facility systems testing results must be included in the building commissioning plan and report or as a separate document.	R
Carbon Dioxide (CO_2) Monitoring Provide capacity for indoor air quality (IAQ) monitoring to sustain long-term occupant health and comfort.	
Credit Requirements Install a permanent carbon dioxide (CO_2) monitoring system that provides feedback on space ventilation performance in a form that affords operational adjustments, AND specify initial operational set point parameters that maintain indoor carbon dioxide levels no higher than outdoor levels by more than 530 parts per million at any time.	1

MIT Design Requirements

Indoor Environmental Quality	LEED
Increase Ventilation Effectiveness Provide for the effective delivery and mixing of fresh air to support the health, safety, and comfort of building occupants.	
Credit Requirements For mechanically ventilated buildings, design ventilation systems that result in an air change effectiveness (E) greater than or equal to 0.9 as determined by ASHRAE 129-1997. For naturally ventilated spaces demonstrate a distri bution and laminar flow pattern that involves not less than 90% of the room or zone area in the direction of air flow for at least 95% of hours of occu-pancy.	1
Construction IAQ Management Plan Prevent indoor air quality problems resulting from the construction/renovation process, to sustain long-term installer and occupant health and comfort.	
Credit Requirements Develop and implement an Indoor Air Quality (IAQ) Management Plan for the construction and preoccupancy phases of the building as follows: During construction meet or exceed the minimum requirements of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guideline for Occupied Buildings under Construction, 1995, AND protect stored on-site or installed absorptive materials from moisture damage, AND replace all filtration media immediately prior to occupancy. Filtration media shall have a Minimum Efficiency Reporting Value (MERV) of 13 as determined by ASHRAE 52.2-1999.	1
Credit Requirements Develop and implement an Indoor Air Quality (IAQ) Management Plan for the construction and preoccupancy phases of the building as follows: Conduct a minimum two-week building flush-out with new filtration media at 100% outside air after construction ends and prior to occupancy, OR conduct a baseline indoor air quality testing procedure consistent with current EPA Protocol for Environmental Requirements, Baseline IAQ and Materials, for the Research Triangle Park Campus, Section 01445.	1
Low-Emitting Materials Reduce the quantity of indoor air contaminants that are odorous or potentially irritating to provide installer and occupant health and comfort.	
Credit Requirements Meet or exceed VOC limits for adhesives, sealants, paints, composite wood products, and carpet systems as follows: Adhesives must meet or exceed the VOC limits of South Coast Air Quality Management District Rule #1168 by, AND all sealants used as a filler must meet or exceed Bay Area Air Quality Management District Reg. 8, Rule 51.	1

MIT Design Requirements

Indoor Environmental Quality	LEED
Credit Requirements Meet or exceed VOC limits for adhesives, sealants, paints, composite wood products, and carpet systems as follows: Paints and coatings must meet or exceed the VOC and chemical component limits of Green Seal requirements.	1
Credit Requirements Meet or exceed VOC limits for adhesives, sealants, paints, composite wood products, and carpet systems as follows: Carpet systems must meet or exceed the Carpet and Rug Institute Green Label Indoor Air Quality Test Program.	1
Credit Requirements Meet or exceed VOC limits for adhesives, sealants, paints, composite wood products, and carpet systems as follows: Composite wood and agrifiber products must contain no added urea-formaldehyde resins.	1
Indoor Chemical and Pollutant Source Control Avoid exposure of building occupants to potentially hazardous chemicals that adversely impact air quality.	
Credit Requirements Design to minimize cross-contamination of regularly occupied occupancy areas by chemical pollutants: Employ permanent entry way systems (grills, grates, etc.) to capture dirt, particulates, etc. from entering the building at all high volume entry ways, AND provide areas with structural deck to deck partitions with separate outside exhausting, no air recirculation and negative pressure where chemical use occurs (including housekeeping areas and copying/print rooms), AND provide drains plumbed for appropriate disposal of liquid waste in spaces where water and chemical concentrate mixing occurs.	1
Controllability of Systems Provide a high level of individual occupant control of thermal, ventilation, and lighting systems to support optimum health, productivity, and comfort conditions.	
Credit Requirements Provide a minimum of one operable window and one lighting control zone per 200 SF for all occupied areas within 15 feet of the perimeter wall.	1

MIT Design Requirements

Indoor Environmental Quality

		LEED
☐	**Credit Requirements** Provide controls for each individual for airflow, temperature, and lighting for **50%** of the non-perimeter, regularly occupied areas.	1
	Thermal Comfort Provide for a thermally comfortable environment that supports the productive and healthy performance of the building occupants.	
☐	**Credit Requirements** Comply with ASHRAE Standard 55-1992, Addenda 1995 for thermal comfort standards including humidity control within established ranges per climate zone.	1
☐	**Credit Requirements** Install a permanent temperature and humidity monitoring system configured to provide operators control over thermal comfort performance and effectiveness of humidification and/ or dehumidification systems in the building.	1
	Daylight and Views Provide a connection between indoor spaces and outdoor environments through the introduction of sunlight and views into the occupied areas of the building.	
☐	**Credit Requirements** Achieve a minimum Daylight Factor of 2% (excluding all direct sunlight penetration) in **75%** of all space occupied for critical visual tasks, not including copy rooms, storage areas, mechanical, laundry, and other low occupancy support areas. Exceptions include those spaces where tasks would be hindered by the use of daylight or where accomplishing the specific tasks within a space would be enhanced by the direct penetration of sunlight.	1
☐	**Credit Requirements** Direct line of sight to vision glazing from **90%** of all regularly occupied spaces, not including copy rooms, storage areas, mechanical, laundry, and other low occupancy support areas.	1

Indoor Environmental Quality Score 15 Possible LEED Points	**Total:**

Innovation & Design Process

LEED

Innovation in Design
To provide design teams and projects the opportunity to be awarded points for exceptional performance above requirements set by the LEED Green Building Rating System$_{TM}$ and/or innovative performance in Green Building categories not specifically addressed by the LEED Green Building Rating System$_{TM}$.

Credit Requirements
In writing, using the LEED$_{TM}$ Credit Equivalence process, identify the intent of the proposed innovation credit, the proposed requirement for compliance, the proposed submittals to demonstrate compliance, and the design approach used to meet the required elements, up to four innovations possible.

1 to 4

LEED Accredited Professional
To support and encourage the design integration required by a LEED$_{TM}$ Green Building project and to streamline the application and certification process.

Credit Requirements
At least one principal participant of the project team that has successfully completed the LEED$_{TM}$ Accredited Professional exam.

1

Innovation & Design Process Score

5 Possible LEED Points

Total:

Total Project Score

69 Possible Total LEED Points

Total:

Resources

Background Concepts

Agenda 21
- Agenda 21 & Other UNCED Agreements
  - http://www.igc.org/habitat/agenda
- Agenda 21 and Sustainable Development
  - http://www.iol.ie/~isp/agenda21/
- Agenda 21 - National Information
  - http://www.un.org/esa/agenda21/natlinfo/index.html

Ecological Footprints
- Revisiting Carrying Capacity: Area-Based Indicators of Sustainability
  - http://www.dieoff.com/page110.htm Sustainability
- What is an Ecological Footprint?
  - http://www.esb.utexas.edu/drnrm/WhatIs/ecofootprint.htm

Ecosystem
- Complexity and Connectivity in Ecosystems
  - http://www.csu.edu.au/ci/vol03/klomp/klomp.html
- Ecosystem Valuation
  - http://www.ecosystemvaluation.org/

Green Economics
- Green Economics Website
  - http://www.greeneconomics.net/

Sustainability
- Applying Sustainable Development
  - http://www.applysd.co.uk
- Brain Food
  - http://www.dieoff.com/
- Center for Renewable Energy and Sustainable Technology
  - http://www.crest.org/
- Consulting the Public Interest
  - http://www.cipi.com/artclsus.shtml
- Deep Sustainability [National Centre for Sustainability (NCFS)]
  - http://www.islandnet.com/~ncfs/ncfs/
- Defining Sustainability
  - http://www.arch.wsu.edu/~sustain/defnsust.htm
- Department of Energy Library
  - http://vm1.hqadmin.doe.gov/library/
- Department of Energy - EnergyFiles
  - http://www.osti.gov/EnergyFiles/
- Ecosustainable - Sustainable Environment
  - http://www.ecosustainable.com.au/links.htm
- Environment & Sustainable Living
  - http://condor.stcloudstate.edu/~dmichael/eco/
- Factor Four (abstract)
  - http://www2.wupperinst.org/
- The Florida Center for Understanding Sustainability
  - http://www.ficus.usf.edu/
- Indicators of Sustainability Training Course
  - http://www.sustainablemeasures.com/

Institute of Energy and Sustainable Design
http://www.iesd.dmu.ac.uk/ecadap/ecadap.htm
Interagency Working Group on Sustainable Development Indicators
http://www.sdi.gov/iwgsdi.htm
A Paradigm for Sustainability (by Richard Risemberg)
http://www.living-room.org/sustain/paradigm.htm
Sources of Sustainability
http://csf.colorado.edu/elsewhere/index.html
Sustainable Energy Authority
http://www.sea.vic.gov.au/building/ESCB/links.htm
Sustainable Measures
http://www.sustainablemeasures.com/
The Sustainability Report
http://www.sustreport.org/
Towards Sustainability
http://www.towards-sustainability.co.uk/y
World Bank
http://www.worldbank.org/

Sustainable Architecture

Alternative Architecture and Sustainable Development
http://apocalypse.org/pub/u/paul/arch.html
Architecture and Building
http://library.nevada.edu/arch/rsrce/webrsrce/main0018.html
Architecture and Community
http://csf.colorado.edu/sustainability/community.htm
Earthship Architecture
http://www.earthship.org/home.htm
Environmental Design and Sustainability
http://www.arch.vt.edu/Sustainability/extras/website.htm
Environmental Sustainable Architecture
http://enertia.com/envirarc.htm
Green Building Primer
http://www.energybuilder.com/greenbld.htm
Green Design Sustainable Architecture
http://www.lib.berkeley.edu/ENVI/GreenAll.htm
The Hannover Principles
http://minerva.acc.virginia.edu/~arch/pub/hannover_list.htm
Sustainable Architecture
http://members.aol.com/reidybrown/htmldocs/architecture archpg1.htm
Sustainable Architecture Building and Culture
http://www.sustainableabc.com/
Sustainable Architecture Resource
http://www.umich.edu/~nppcpub/resources/ResLists/arch.html
Sustainable Building Resource
http://www.iris.ba.cnr.it/sustain/welcome.asp
Sustainable Building Sourcebook
http://www.greenbuilder.com/sourcebook/contents.htm

Urban Sustainability

Database on Good Practice in Urban Management and Sustainability

http://europa.eu.int/comm/urban/
Florida Internet Center for Understanding Sustainability (FICUS)
http://www.ficus.usf.edu/
Green Communities Assistance Kit
http://www.epa.gov/greenkit/
Livable Communities
http://www.livablecommunities.gov/
Living Room
http://www.living-room.org/
Smart Growth Network
http://www.smartgrowth.org/
SURBAN (database on sustainable urban development in Europe)
http://www.eaue.de/winuwd/default.htm
Sustainable Communities Resource Package (SCRP)
http://www.web.net/ortee/scrp/
Sustainable Urban Design and Climate
http://www.bom.gov.au/climate/environ/design/design.shtml
Urban Ecology Australia
http://www.urbanecology.org.au/
Urban Ecology Design Collaborative
http://www.urbanecology.com/
The Virtual Library on Urban Environmental Management
http://www.gdrc.org/uem/Sustainable Urban Design and Climate

Associations & Directories

American Indoor Air Quality Council
http://www.iaqcouncil.org/
American Institute of Architecture
http://www.e-architect.com/home2.asp
American Solar Energy Society
http://www.ases.org/
Architects, Designers and Planners for Social Responsibility (ADPSR)
http://www.adpsr.org/
BASEA - Boston Area Solar Energy Association
http://www.basea.org/
Building Concerns
http://www.interiorconcerns.org/
Business for Social Responsibility (BSR)
http://www.bsr.org/
Climate Action Network (CAN)
http://www.climatenetwork.org/
Committee on the Environment (COTE)
http://www.e-architect.com/pia/cote/home2.asp
Ecological Design Institute (EDI)
http://www.ecodesign.org/edi/
Environ Design Collaborative
http://www.environdc.com/
EPA's Environmentally Preferable Purchasing (EPP)
http://www.epa.gov/opptintr/epp
Green Building Alliance (Pittsburgh)
http://www.gbapgh.org/
Green Building Information Council (GBIC), Canada
http://greenbuilding.ca/
Green Round Table: Sustainable Architecture and Design
http://www.greenroundtable.org/
thegreenpages.ca
http://www.thegreenpages.org/
The Healthy House Institute (HHI)
http://www.hhinst.com/
Intergovernmental Panel on Climate Change (IPCC)
http://www.ipcc.ch/
National Pollution Prevention Center for Higher Education (NPPC)
http://www.umich.edu/~nppcpub/index.html
The Natural Step (US)
http://www.naturalstep.org/
North East Sustainble Energy Association- NESEA
http://www.nesea.org/
Office of Building Technology, State and Community Programs
http://www.eren.doe.gov/buildings/
Partnership for Advanced Technology in Housing (PATH)
http://www.pathnet.org/
Second Nature
http://www.secondnature.org/
Society of Building Science Educators

http://www.polaris.net/~sbse/web/sbsehome.htm
- Soil and Water Conservation Society (SWCS)
  - http://www.swcs.org/
- SD (Sustainable Development) Gateway
  - http://www.sdgateway.net/
- United Nations Framework Convention on Climate Change (UNFCCC)
  - http://www.unfccc.de/
- Urban Ecology
  - http://www.urbanecology.org/
- U.S. Green Building Council (USGBC)
  - http://www.usgbc.org/
- The Used Building Materials Association (UBMA)
  - http://www.ubma.com/
- WSU Cooperative Extension Energy Program
  - http://www.energy.wsu.edu
- Wisconsin Green Building Alliance (WGBA)
  - http://www.wgba.org/

Research Centers
- Center for Energy Efficiency & Renewable Technologies (CEERT)
  - http://www.ceert.org/home.html
- Center of Excellence for Sustainable Development (CESD), USDOE
  - http://www.sustainable.doe.gov/
- Center for Maximum Potential Building Systems (CMPBS)
  - http://www.cmpbs.org/
- Center for Resourceful Building Technology (CRBT)
  - http://www.montana.com/crbt/
- Center for Sustainable Systems - Environmental Energy Technologies Division
  - http://eetd.lbl.gov/
- FICUS-Florida Internet Center for Understanding Sustainability
  - http://www.ficus.usf.edu/
- Green Resource Center, Berkeley
  - http://www.greenresourcecenter.org/
- MIT Building Technology Group
  - http://web.mit.edu/bt/www/
- Pacific Energy Center
  - http://www.pge.com/003_save_energy/003c_edu_train/pec/003c1_pac_energy.shtml
- Rocky Mountain Institute (RMI)
  - http://www.rmi.org/
- Sandia National Laboratories Renewable Energy Office
  - http://www.sandia.gov/Renewable_Energy/renewable.html
- Simulation Research Group
  - http://gundog.lbl.gov/
- Sustainability Research Profiles [Second Nature]
  - http://www.secondnature.org/programs/profiles.nsf
- The Vital Signs Project
  - http://www.arch.ced.berkeley.edu/vitalsigns/

Building Materials

Material Selection Guides
- AIA Environmental Resource Guide
  - http://www.e-architect.com/pia/erg/erghome.asp
- Casey and Amber's Sustainable Building Materials
  - http://www.uark.edu/depts/dbertonc/CaseyandAmber/index.htm
- EnCompass - Map of Recycled Content Buildings
  - http://dnr.metrokc.gov/market/encompass/index.htm
- Green Building Databases & Design Resources
  - http://www.greenbuilder.com/general/GreenDBs.html
- GreenSpec
  - http://www.greenspec.com/directory/CSI2.html
- Recycled Content Product Database [California Integrated Waste Management Board]
  - http://www.ciwmb.ca.gov/rcp/
- Sustainable Design Resource Guide
  - http://www.aiacolorado.org/SDRG/intro/index.html

Concrete Reuse
- Cement and Concrete: Environmental Considerations [EBN]
  - http://www.buildinggreen.com/features/cem/cementconc.html
- Concrete Network
  - http://www.concretenetwork.com/concrete/countertops/index.html

Drainwater Heat Recovery
- Drainwater Heat Recovery (DHR) System - Gravity Film Exchange (GFX)
  - http://oikos.com/gfx/
- GFX Drainwater Heat Recovery
  - http://www.eren.doe.gov/buildings/emergingtech/printable/page2d.html

Greywater Treatment
- Greywater irrigation - grey waste treatment
  - http://www.greywater.com/
- Living Technologies
  - http://www.livingmachines.com/
- Oasis Design
  - http://www.oasisdesign.net/
- On-Site Wastewater Treatment Systems [Green Center]
  - http://www.fuzzylu.com/greencenter/tb/tb006.htm
- Waterless urinals
  - http://www.waterless.com/
- WaterWiser
  - http://www.waterwiser.org/

Natural Ventilation
- Energy recovery possibilities in natural ventilation of office buildings
  - http://www.byggforsk.no/english/energy.htm
- How Natural Ventilation Works
  - http://www.ae.iastate.edu/natural_ventilation.htm
- Natural Ventilation
  - http://fridge.arch.uwa.edu.au/topics/thermal/airflow/ventilation.html
- Natural ventilation system with heat recovery
  - http://www.caddet-ee.org/nl_html/994_07.htm
- Natural Ventilation - A strategy for sustainability [MIT]

http://naturalvent.mit.edu/

Post-Occupancy Evaluation (POE) or Building Pathology

Post Occupancy Evaluation

http://ind4601-01.sp00.fsu.edu/POEabb/

Post-Occupancy Evaluation of Higher Education Teaching Spaces - A Methodological Approach

http://www.scpm.salford.ac.uk/buhu/bizfruit/1998papers/dilanthi/dilanthi.htm

Post Occupancy Evaluation of San Francisco Public Library

http://sfpl.lib.ca.us/www/poe_executive_summary.html

The Power of POE

http://www.fdm.com/db_area/archives/1999/9906/poe.html

Solar Air-conditioning

Solar-powered air conditioning

http://www.thesrtgroup.com/prod03.htm

Solar powered LiBr chillers

http://www.suntherm.com/chillers.htm

SC1000-SolarCool DC Evaporative Cooler

http://www.longcayebelize.com/ecovillage/Solar Air Conditioning.htm

Green Building Guidelines & Programs

Guidelines
- Greening Federal Facilities
  - http://www.eren.doe.gov/femp/greenfed/
- Guiding Principles of Sustainable Design - US Park Services
  - http://www.nps.gov/dsc/dsgncnstr/gpsd/toc.html
- High Performance Building Guidelines - Pennsylvania
  - http://www.gggc.state.pa.us/publictn/gbguides.html
- Minnesota Sustainable Design Guide
  - http://www.sustainabledesignguide.umn.edu/
- New York City Department of Design and Construction
  - http://www.ci.nyc.ny.us/html/ddc/html/pdfdl.html#guidelines
- Process Guide for High Performance Buildings - Florida
  - http://sustainable.state.fl.us/fdi/edesign/resource/index.html
- EPA & USGBC – Sustainable Building Technical Manual
  - http://www.sustainable.doe.gov/pdf/sbt.pdf
- Greening Federal Facilities - Federal Agency Management Program
  - http://www.eren.doe.gov/femp/greenfed/
- Sustainable Building Handbook - Hellmuth, Obata & Kassabaum, Inc.
  - http://www.hok.com/sustainabledesign/
- United States Air Force Environmentally Responsible Facilities Guide
  - http://www.aett.gov.bc.ca/environmental/data/environt/sec-one.htm#sec-one
- United States Air Force – Green Base of the Future
  - http://www.dexix.osd.mil/denix/Public/Library/Eprfguide/eprf1.html
- United States Navy Whole Building Design Guide
  - http://www.wbdg.org/
- U.S. Postal Service – Building Design Standards

Green City Programs
- Alameda County Waste Authority
  - http://www.stopwaste.org/fsbuild.html
- Cambridge Sustainable City
  - http://www.sustainablecity.net/
- City of Austin Green Building Program
  - http://www.aett.gov.bc.ca/environmental/data/environt/sec-one.htm - sec-one
- Denver, Colorado – Built Green
  - http://www.builtgreen.org/
- Green City Project
  - http://www.green-city.org/
- Green Design / Sustainable Architecture Information Sources [UC Berkeley]
  - http://www.lib.berkeley.edu/ENVI/GreenAll.html
- Green Design Initiative (GDI)
  - http://www.ce.cmu.edu/GreenDesign/
- Los Angeles, California - Green Building Guidelines
  - http://www.globalgreen.org/pdf/index.html
- Oakland, California - How-to Design Guide for Green Buildings
- Philadelphia, Pennsylvania – Save Energy Campaign
- San Francisco, California - Strategies for Resource Efficient Buildings
  - http://www.ci.sf.ca.us/90043.htm
- San Jose, California - Local Guidelines & Incentives
- Santa Monica Green Building Guidelines
  - http://greenbuildings.santa-monica.org/sitemap.htm

Scottsdale Green Building Program
http://www.ci.scottsdale.az.us/greenbuilding/RatingWS.aspGreen Design Initiative (GDI)
Seattle Sustainable Building
http://www.ci.seattle.wa.us/seattle/util/rescons/susbuild/default.htm
Seattle, Washington – Sustainable Building Action Plan
http://www.ci.seattle.wa.us/seattle/util/rescons/susbuild/default.htm

State & County Municipalities
Alameda County, California - Green Builder Guidelines
http://www.stopwaste.org/fsbuild.htm
Central New Mexico – Green Builder
Hennepin County, Minnesota - Sustainable Design Guide and Rating System
http://www.sustainabledesignguide.umn.edu/
Kitsap County – Build a Better Kitsap
http://www.wa.gov/kitsap/departments/pubworks/buildbetter.html
Nebraska – Moving Toward Sustainability
Florida - Process Guidelines for High Performance Buildings
http://sustainable.state.fl.us/fdi/edesign/resource/index.html
Suburban Maryland – Building Green

Environmental Performance Rating Systems
Bepac – British Columbia
http://www.bepac.dmu.ac.uk/index.html#What’s_Here
Breeam – UK
http://www.bre.co.uk/index.html
Breeam Office 1998 – Canada
http://www.breeamcanada.ca/
British Columbia University – Facilities Branch Environmental Guidelines
http://www.aett.gov.bc.ca/environmental/data/environt/sec-one.htm#sec-one
U.S. Green Building Council – LEED
http://www.usgbc.org/

Design & Simulation Tools

Simulation Tools
- BE2AM: Building Energy and Environmental Assessment Method
  - http://www.ecde.demon.co.uk/be2am.htm
- Building Energy Software: Tools Directory
  - http://www.eren.doe.gov/buildings/tools_directory/
- Environmental Support Solutions
  - http://www.environ.com/
- EQUER (France)
  - http://www-cenerg.ensmp.fr/francais/batiment/15.html
- Global Environmental Options (GEO)
  - http://www.geonetwork.org/
- Green Buildings [Center of Excellence for Sustainable Development]
  - http://www.sustainable.doe.gov/buildings/gbintro.htm
- International Association for Impact Assessments (IAIA)
  - http://www.iaia.org/
- Introduction to OTTV and Simulation Tools
  - http://arch.hku.hk/~cmhui/teach/65256-X.htm

Computer-based Tools
- Building Energy Simulation Tools
  - http://www.inf.bauwesen.tu-muenchen.de/personen/christop/bsim/building_energy.htm
- Green Buildings [Center of Excellence for Sustainable Development]
  - http://www.sustainable.doe.gov/buildings/gbintro.htm
- Interactive Tools Survey [University of Weimar, Germany]
  - http://www.uni-weimar.de/SCC/PRO/TOOLS/inter.html

Life Cycle Analysis and Costing
- Activity-Based Management
  - http://www.emblemsvag.com/
- ATHENA Sustainable Materials Institute
  - http://www.athenasmi.ca/
- BEES (Building for Environmental and Economic Sustainability)
  - http://www.bfrl.nist.gov/oae/software/bees.html
- Buildings and Life-Cycle Costing [Canadian Building Digest]
  - http://www.nrc.ca/irc/cbd/cbd212e.html
- Comparing the Environmental Effects of Building Systems [Canadian Wood Council]
  - http://www.cwc.ca/english/publications/technical_bulletins/tech_bull_4/
- Eco-Quantum (Netherlands)
  - http://www.ivambv.uva.nl/uk/producten/product7.htm
- ENVEST (environmental impact estimating design software) [UK BRE]
  - http://products.bre.co.uk/envest/
- LCAid (Australia)
  - http://www.projectweb.gov.com.au/dataweb/lcaid/
- Life Cycle Analysis for Residential Buildings [Canadian Wood Council]
  - http://www.cwc.ca/english/publications/technical_bulletins/tech_bull_5/
- Life-Cycle Assessment
  - http://www.emblemsvag.com/LCA.htm
- Life-Cycle Costing
  - http://dept.lamar.edu/industrial/Graduate/..%5CClasses/..%5CUnderdown/eng_mana/Life_Cycle_Costing_Shtub_ch10.htm
- Life Cycle Costing and Stainless Steel

http://www.assda.asn.au/lifecycle1.html

Life Cycle Costing Program-Version 2.0

http://www.assda.asn.au/lifecycle1.html

LISA (LCA in Sustainable Architecture)

http://www.lisa.au.com/

Design Tools

Building Design Advisor

http://kmp.lbl.gov/BDA/

Energy Design Tools

http://www.aud.ucla.edu/energy-design-tools/

Green Building Advisor

Green Campus Initiatives

Blueprint for a Green Campus
    http://www.envirocitizen.org/cgv/blueprint/index.html
British Columbia University
    http://www.aett.gov.bc.ca/environmental/data/environt/sec-one.htm
Brown is Green
    http://www.brown.edu/Departments/Brown_Is_Green/
Building a Green Campus
    http://www.uvm.edu/~jfrances/report.html
Carnegie Melon – Green Design Initiative
CSU, Monterey Bay – Greening of the Campus
    http://kelp.monterey.edu/const/index.shtml
Duke University – Environmental Sustainability Program
Environmental Education and Campus Greening
    http://www.lib.msu.edu/link/enved.htm
FGCU Green Building Project
    http://www.fgcu.edu/greenbuilding/index.html
Florida A&M University – Guidelines & Principles for Sustainable Community Design
    http://fcn.state.fl.us/fdi/index.html
Georgia Tech – Primer for Sustainable Design
Green Campus Design Saving 60% on Energy [CSIRO]
    http://www.dbce.csiro.au/inno-web/0600/green_campus.htm
Green Campus Issues [Havard]
    http://hcs.harvard.edu/~eac/greencampus.htm
Greening the Campus: Sustainability and Higher Education
    http://www.islandpress.org/economics/energy/greencamp.html
Merced Campus – Principle Initiative
Middlebury College – Guiding Principles
    http://www.middlebury.edu/~enviroc/content.html
Sustainability - Green Campus Initiatives
    http://www.epa.gov/region01/steward/univ/sus.html
Sustainable Development on Campus [IISD]
    http://iisd1.iisd.ca/educate/
Tufts University - Greening the Ivory Tower
University of Michigan, Sustainable Architecture
    http://www.umich.edu/~nppcpub/resources/compendia/architecture.html
University of Washington – Facility Design Information Manual
    http://depts.washington.edu/~fsesweb/fdi99/index.html

Case Studies

901 Cherry in San Bruno, California
http://bacqube.bayareacouncil.org/901/
Adam J. Lewis Center for Environmental Studies
http://www.oberlin.edu/newserv/esc/
Audubon House: Building for an environmental future
http://www.audubon.org/nas/ah/index.html
Barney-Davis Green Renovation
http://www.denison.edu/enviro/barney/
Beddington Zero Energy Development (BedZED)
http://www.bedzed.org.uk/
BRE Environmental Building at Garston
http://projects.bre.co.uk/envbuild/index.html
Case Studies [Smart Growth Network]
http://www.smartgrowth.org/casestudies/casestudy_index.html
Case Studies at HKU Arch
http://arch.hku.hk/research/BEER/casestud.htm
Chattanooga Sustainability Page
http://new.chattanooga.net/sustain/
C. K. Choi Building, Institute of Asian Research, University of British Columbia, Canada
http://www.iar.ubc.ca/choibuilding/matsuzaki.html
Current Projects of Sustainable Urban Housing in China [MIT Building Technology]
http://chinahousing.mit.edu/english/projects/
Demonstration House I
http://greenhome.org/demo.htm
Department of Environmental Protection, Commonwealth of Pennsylvania Cambria Office
http://www.gggc.state.pa.us/building/Cambria/default.htm
ECO DESIGN Octagonal Yurt building
http://www.powerup.com.au/~edesign/yurtpage1.htm
Ecoschool
http://www.takenaka.co.jp/takenaka_e/school_e/sch03/03_4.html
enCompass - map of recycled-content buildings
http://dnr.metrokc.gov/market/encompass/index.htm
Environmentally Responsible Projects
http://www.takenaka.co.jp/takenaka_e/env_pro_e/index.htm
Green Buildings Success Stories [CESD]
http://www.sustainable.doe.gov/buildings/gbsstoc.htm
Green Development Case Studies [RMI]
http://www.rmi.org/sitepages/pid199.asp
GreenHome
http://greenhome.org/
HOK Sustainable Design - Case Studies
http://www.hok.com/sustainabledesign/casestudies/casestudies.html
Lady Bird Johnson Wildflower Center Complex, Austin Texas
http://www.wildflower.org/hq.html
NEXT 21 (Osaka Gas Experimental Housing)
http://arch.hku.hk/~cmhui/japan/next21/next21-index.html
Pennsylvania's First Green Building: DEP's Southcentral Regional Office Building
http://www.gggc.state.pa.us/building/scrob.html
RITE Head Office
http://arch.hku.hk/~cmhui/japan/rite/rite-index.html

Thoreau Center for Sustainability, San Francisco
http://www.thoreau.org/
UNEP International Environmental Center
http://arch.hku.hk/~cmhui/japan/unep/unep-index.html
US Green Building Council - Green Building Case Studies
http://www.usgbc.org/resource/cs.htm
Village Homes: A model solar community proves its worth
http://context.org/ICLIB/IC35/Browning.htm
Vital Signs Case Studies
http://www.arch.ced.berkeley.edu/vitalsigns/
Zion Canyon Visitor and Transportation Center, NREL
http://www.nrel.gov/buildings/highperformance/projects/zion/zion.htm

Green Design Review Checklist

The following has been adapted from the U S Green Building Council - LEED ™ Rating System 2.0
For the full disclosure of the intent, requirement, technologies/strategies of the LEED document, please refer to the USGBC website: http://www.usgbc.org/

Sustainable Sites

		14 Possible LEED Points
Prereq 1	**Erosion & Sedimentation Control**	Required
_X_ Credit 1	**Site Selection**	1
_X_ Credit 2	**Urban Redevelopment**	1
_X_ Credit 3	**Brownfield Redevelopment**	1
_X_ Credit 4.1	**Alternative Transportation,** Public Transportation Access	1
___ Credit 4.2	**Alternative Transportation,** Bicycle Storage & Changing Rooms	1
___ Credit 4.3	**Alternative Transportation,** Alternative Fuel Refueling Stations	1
___ Credit 4.4	**Alternative Transportation,** Parking Capacity	1
___ Credit 5.1	**Reduced Site Disturbance,** Protect or Restore Open Space	1
___ Credit 5.2	**Reduced Site Disturbance,** Development Footprint	1
___ Credit 6.1	**Stormwater Management,** Rate or Quantity	1
___ Credit 6.2	**Stormwater Management,** Treatment	1
___ Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands,** NonRoof	1
___ Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands,** Roof	1
___ Credit 8	**Light Pollution Reduction**	1
	Sustainable Sites Totals - LEED	

Water Efficiency

		5 Possible LEED Points
___ Credit 1.1	**Water Efficient Landscaping,** Reduce by 50%	1
___ Credit 1.2	**Water Efficient Landscaping,** No Potable Use or No Irrigation	1
___ Credit 2	**Innovative Wastewater Technologies**	1
___ Credit 3.1	**Water Use Reduction,** 20% Reduction	1
___ Credit 3.2	**Water Use Reduction,** 30% Reduction	1
	Materials & Resources Totals - LEED	

Energy & Atmosphere

		17 Possible LEED Points
Prereq 1	**Fundamental Building Systems Commissioning**	Required
Prereq 2	**Minimum Energy Performance**	Required
Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
___ Credit 1.1	**Optimize Energy Performance,** 20% New / 10% Existing	2
___ Credit 1.2	**Optimize Energy Performance,** 30% New / 20% Existing	2
___ Credit 1.3	**Optimize Energy Performance,** 40% New / 30% Existing	2
___ Credit 1.4	**Optimize Energy Performance,** 50% New / 40% Existing	2
___ Credit 1.5	**Optimize Energy Performance,** 60% New / 50% Existing	2
___ Credit 2.1	**Renewable Energy,** 5%	1
___ Credit 2.2	**Renewable Energy,** 10%	1
___ Credit 2.3	**Renewable Energy,** 20%	1
___ Credit 3	**Additional Commissioning**	1

___ Credit 4	**Ozone Depletion**	1
___ Credit 5	**Measurement & Verification**	1
___ Credit 6	**Green Power**	1
	Energy & Atmosphere Totals - LEED	

Materials & Resources

		13 Possible LEED Points
Prereq 1	**Storage & Collection of Recyclables**	Required
___ Credit 1.1	**Building Reuse,** Maintain 75% of Existing Shell	1
___ Credit 1.2	**Building Reuse,** Maintain 100% of Shell	1
___ Credit 1.3	**Building Reuse,** Maintain 100% Shell & 50% Non-Shell	1
___ Credit 2.1	**Construction Waste Management,** Divert 50%	1
___ Credit 2.2	**Construction Waste Management,** Divert 75%	1
___ Credit 3.1	**Resource Reuse,** Specify 5%	1
___ Credit 3.2	**Resource Reuse,** Specify 10%	1
___ Credit 4.1	**Recycled Content,** Specify 25%	1
___ Credit 4.2	**Recycled Content,** Specify 50%	1
___ Credit 5.1	**Local/Regional Materials,** 20% Manufactured Locally	1
___ Credit 5.2	**Local/Regional Materials,** 50% Harvested Locally	1
___ Credit 6	**Rapidly Renewable Materials**	1
___ Credit 7	**Certified Wood**	1
	Materials & Resources Totals - LEED	

Indoor Environmental Quality

		15 Possible LEED Points
Prereq 1	**Minimum IAQ Performance**	Required
Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
___ Credit 1	**Carbon Dioxide** (CO_2) **Monitoring,** Monitoring Sensors	1
___ Credit 2	**Increase Ventilation Effectiveness,** Air Change	1
___ Credit 3.1	**Construction IAQ Management Plan,** During Construction	1
___ Credit 3.2	**Construction IAQ Management Plan,** Before Occupancy	1
___ Credit 4.1	**Low-Emitting Materials,** Adhesives & Sealants	1
___ Credit 4.2	**Low-Emitting Materials,** Paints	1
___ Credit 4.3	**Low-Emitting Materials,** Carpet	1
___ Credit 4.4	**Low-Emitting Materials,** Composite Wood	1
___ Credit 5	**Indoor Chemical & Pollutant Source Control**	1
___ Credit 6.1	**Controllability of Systems,** Perimeter	1
___ Credit 6.2	**Controllability of Systems,** Non-Perimeter	1
___ Credit 7.1	**Thermal Comfort,** Comply with ASHRAE 55-1992	1
___ Credit 7.2	**Thermal Comfort,** Permanent Monitoring System	1
___ Credit 8.1	**Daylight & Views,** Daylight 75% of Spaces	1
___ Credit 8.2	**Daylight & Views,** Views for 90% of Spaces	1
	IEQ Totals - LEED	

Innovation & Design Process

			5 Possible LEED Points
___	Credit 1.1	**Innovation in Design**: Specific Title	1
___	Credit 1.2	**Innovation in Design**: Specific Title	1
___	Credit 1.3	**Innovation in Design**: Specific Title	1
___	Credit 1.4	**Innovation in Design**: Specific Title	1
___	Credit 2	**LEED™ Accredited Professional**	1
		Innovation & Design Totals - LEED	

Project Totals

LEED:
Required minimum: 33 points

Signature of Designer or Consultant ______________________________

Dated ________________________

DIVISION 1 - GENERAL REQUIREMENTS

1. **General Requirements:** CSI Masterformat uses General Requirements as a logical place to include general information which pertains to the performance of the work, which are administrative in nature, and which are common to other specification divisions. General Requirements are considered Technical Specifications and often include information such as submittal procedures which, if not stated in the General Requirements, would need to be repeated in each specification section.

   A. Obtain the appropriate M.I.T. "front end" from the M.I.T. Project Manager. Use the M.I.T. Division 1 as a model and modify only those portions indicated to be modified.

2. **Preventive Maintenance:** The Designer should require the General Contractor, through the M.I.T. Project Manager, to contact the PM Office whenever work being performed involves the removal or relocation of existing equipment or the installation of new equipment. This requirement also applies to in-house contractors. This includes HVAC equipment, fire extinguishers and emergency safety showers. The following procedures should be followed when performing work at M.I.T.:

   A. Notify the PM Office of any equipment being removed.

   B. Notify the PM Office of any equipment being relocated.

   C. The notification must include the equipment number (PM number), building number, and room number.

3. CAD Documents: M.I.T. strongly encourages, and may require, depending on the project, the following documents be provided in CAD format. The Designer should contact the CAD System Administrator, through the M.I.T. Project Manager, for system requirements and current standards prior to the commencement of design. When required, the specifications should clearly indicate the requirements to the Contractor for CAD Record Drawings.

   A. Contract Documents provided by in-house or outside design consultants. This applies to engineering documents as well as architectural documents. When CAD documents are required, M.I.T. reserves the right to request electronic documentation of all drawings at each phase of design. Once completed drawings and specifications are issued for bidding and/or construction, electronic documents will also be required for all subsequent changes to the drawings. At a minimum, the Designer shall be required to deliver CAD documents to M.I.T. when the contract documents are issued for bid.

   B. As-Built Record Drawings: Record Drawings must be first class, easily readable, carefully drafted reproducible drawings produced by carefully and accurately redrafting the Contract Documents to clearly show all deviations from the original Contract Drawings, the precise location of each item of work, and all field changes. Record Drawings must be submitted to and approved by M.I.T. as a prerequisite to final payment to the Contractor.

      1) Electronic Documents: When required, provide electronic copies of all as-built record documents, both drawings and specifications. Drawings shall be AutoCAD compatible and specifications and written documents shall be Microsoft Word compatible. For more detailed information on preparation and format of AutoCAD drawings, contact the Physical Plant CAD System Administrator through the M.I.T. Project Manager.

4. M.I.T. Facilities Drawings and Standard Details: M.I.T. may have CAD documents, depending on the project location and scope, of facility related information and standard details which may be of value to the Designer for integration into the construction documents. To determine the availability of these documents contact the CAD systems Administrator through the M.I.T. Project Manager. The Designer shall be responsible for the usability and appropriateness of these documents.

5. **Uncommon Ordinances and Requirements:** M.I.T. has encountered several situations that may be unique to the Institute and that require specific attention. The following list is not exhaustive but represents recent experience at M.I.T. The Design Professional is responsible for compliance with all applicable codes, laws and regulations.

   A. Metropolitan District Commission: No new structures will be constructed and no additions or modifications to existing structures, in, on or near the water (including new construction or reconfiguration of existing docks, floats and structures on piles) will be made. No new fences, paving or planting projects will be undertaken without prior written Commission approval.

   Approval of proposed construction projects will not be granted until all permits and reviews by appropriate federal, state and local agencies (which may include Conservation Commissions, Division of Waterways (DEQE) and the Army Corps of Engineers) are submitted to the Commission. M.I.T. has the responsibility to discuss the project with these agencies after receiving preliminary Commission approval.

   B. A City of Cambridge Ordinance prohibits the use of razor wire or razor ribbon on fences and limits the use of barbed wire, spikes, or other dangerous materials, or any electric charge to within 10' of the ground level. Consult the Safety Office for detailed information.

   C. ADA Requirements for Kitchenettes: In all kitchenettes, lunch room areas with coffee stations, or similar situations, the sink and at least 24" of adjacent counter shall be installed at an elevation of 34" above the floor. Clear floor area shall be provided below the sink in compliance with the ADAAG. The sink and faucet shall also comply with the ADAAG. Other elements and appliances may be installed at typical heights and would be made accessible as a reasonable accommodation upon request by an employee.

   D. ADA Requirements for Laboratories: The ADAAG *recommend*s that 5% of all multiple work stations of the same type, or at least one, be made accessible to persons with disabilities (see ADA Appendix page A1, 4.1.1(3)). In response, M.I.T. requires that the Designer shall design 5% of all *teaching* lab work stations, or at least one, to conform to the requirements of the ADAAG. This requirement does not apply to research lab work stations.

   E. Aisle Handrails in Assembly Occupancies: When there is more than one riser per seating row, handrails are required in egress aisles (MSBC Section 826.0). The clearance requirements for aisles between rails and seating have implications for the ADA and AAB. The Designer is urged to carefully review this section when designing assembly areas at M.I.T.

F. Handrails and Guardrails: The following is an official interpretation (No. 32-93) received from the State Board of Building Regulations and Standards regarding the use of guardrails:

"At a regular meeting of the Board of Building Regulations and Standards held on Tuesday, 13 April 1993, the Board approved the following interpretation of Section 827.1 of the 5th Edition of the Massachusetts State Building Code, effective immediately":

Question: Is the thirty (30) inch elevation intended to be the limit above which guardrails are required to be installed in accordance with Section 827.1?

Answer: Yes. It is generally established in the BOCA National Building Code (1987) that when the height difference between the walking surface or grade is thirty (30) inches or greater, guardrails are required to be provided.

Question: Is the thirty (30) inch difference in elevation intended to be the point at which guard-rails are required for ramps in addition to stairs or walking surfaces?

Answer: No. Ramps are required to be provided with guardrails (if the ramp has an open side) irrespective of the difference in elevation between the ramp and the adjacent walking surface.

END OF DIVISION 1

SECTION 01027- APPLICATION FOR PAYMENT

PART 1 – GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section specifies administrative and procedural requirements governing the Contractor's Applications for Payment.

B. This Section specifies administrative and procedural requirements governing each prime contractor's Applications for Payment.

1. Coordinate the Schedule of Values and Applications for Payment with the Contractor's Construction Schedule, Submittal Schedule, and List of Subcontracts.

C. Related Sections: The following Sections contain requirements that relate to this Section.

1. Schedules: The Contractor's Construction Schedule and Submittal Schedule are specified in Division 1 Section "Submittals."

1.3 Schedule of Values

A. Coordination: Coordinate preparation of the Schedule of Values with preparation of the Contractor's Construction Schedule.

B. Coordination: Each prime Contractor shall coordinate preparation of its Schedule of Values for its part of the Work with preparation of the Contractors' Construction Schedule.

1. Correlate line items in the Schedule of Values with other required administrative schedules and forms, including:

   a. Contractor's Construction Schedule.
   b. Application for Payment forms, including Continuation Sheets.
   c. List of subcontractors.
   d. Schedule of allowances.
   e. Schedule of alternates.
   f. List of products.
   g. List of principal suppliers and fabricators.
   h. Schedule of submittals.

2. Submit the Schedule of Values to the Owner at the earliest possible date but no later than 7 days before the date scheduled for submittal of the initial Applications for Payment.

3. Subschedules: Where Work is separated into phases requiring separately phased payments, provide subschedules showing values correlated with each phase of payment.

C. Format and Content: Use the Project Manual table of contents as a guide to establish the format for the Schedule of Values. Provide at least one line item for each Specification Section.

1. Identification: Include the following Project identification on the Schedule of Values:

   a. Project name and location.
   b. Name of the Owner.
   c. Project number.
   d. Contractor's name and address.
   e. Date of submittal.

2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:

   a. Related Specification Section or Division.
   b. Description of Work.
   c. Name of subcontractor.
   d. Name of manufacturer or fabricator.
   e. Name of supplier.
   f. Change Orders (numbers) that affect value.
   g. Dollar value.

1) Percentage of Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

3. Provide a breakdown of the Contract Sum in sufficient detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Break principal subcontract amounts down into several line items.

4. Round amounts to nearest whole dollar; the total shall equal the Contract Sum.

5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment, purchased or fabricated and stored, but not yet installed.

   a. Differentiate between items stored on-site and items stored off-site. Include requirements for insurance and bonded warehousing, if required.

6. Provide separate line items on the Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the Work.

7. Unit-Cost Allowances: Show the line-item value of unit-cost allowances, as a product of the unit cost, multiplied by the measured quantity. Estimate quantities from the best indication in the Contract Documents.

8. Margins of Cost: Show line items for indirect costs and margins on actual costs only when such items are listed individually in Applications for Payment. Each item in the Schedule of Values and Applications for Payment shall be complete. Include the total cost and proportionate share of general overhead and profit margin for each item.

   a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at the Contractor's option.

9. Schedule Updating: Update and resubmit the Schedule of Values prior to the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.1 Application for Payment

A. Each Application for Payment shall be consistent with previous applications and payments as certified and paid by the Owner.

1. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements.

B. Payment-Application Times: Each progress-payment date is indicated in the Agreement. The period of construction Work covered by each Application for Payment is the period indicated in the Agreement.

C. Payment-Application Times: The date for each progress payment is the 15th day of each month. The period covered by each Application for Payment starts on the day following the end of the preceding period and ends 15 days prior to the date for each progress payment.

D. Payment-Application Forms: Use AIA Document G702 and Continuation Sheets G703 as the form for Applications for Payment.

E. Payment-Application Forms: Use forms provided by the Owner for Applications for Payment. Sample copies are included at the end of this Section.

F. Application Preparation: Complete every entry on the form. Include notarization and execution by a person authorized to sign legal documents on behalf of the Contractor. The Owner will return incomplete applications without action.

1. Entries shall match data on the Schedule of Values and the Contractor's Construction Schedule. Use updated schedules if revisions were made.

2. Include amounts of Change Orders and Construction Change Directives issued prior to the last day of the construction period covered by the application.

G. Transmittal: Submit 3 signed and notarized original copies of each Application for Payment to the Owner by a method ensuring receipt within 24 hours. One copy shall be complete, including waivers of lien and similar attachments, when required.

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information related to the application, in a manner acceptable to the Owner.

H. Waivers of Mechanics Lien: With each Application for Payment, submit waivers of mechanics lien from every entity who is lawfully entitled to file a mechanics lien arising out of the Contract and related to the Work covered by the payment.

I. Waivers of Mechanics Lien: With each Application for Payment, submit waivers of mechanics liens from subcontractors, sub-subcontractors and suppliers for the construction period covered by the previous application.

1. Submit partial waivers on each item for the amount requested, prior to deduction for retainage, on each item.

2. When an application shows completion of an item, submit final or full waivers.

3. The Owner reserves the right to designate which entities involved in the Work must submit waivers.

4. Waiver Delays: Submit each Application for Payment with the Contractor's waiver of mechanics lien for the period of construction covered by the application.

   a. Submit final Applications for Payment with or preceded by final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.

5. Waiver Forms: Submit waivers of lien on forms, and executed in a manner, acceptable to the Owner.

J. Initial Application for Payment: Administrative actions and submittals, that must precede or coincide with submittal of the first Application for Payment, include the following:

1. List of subcontractors.
2. List of principal suppliers and fabricators.
3. Schedule of Values.
4. Contractor's Construction Schedule (preliminary if not final).
5. Schedule of principal products.
6. Schedule of unit prices.
7. Submittal Schedule (preliminary if not final).
8. List of Contractor's staff assignments.
9. List of Contractor's principal consultants.
10. Copies of building permits.
11. Copies of authorizations and licenses from governing authorities for performance of the Work.
12. Initial progress report.
13. Report of preconstruction meeting.
14. Certificates of insurance and insurance policies.
15. Performance and payment bonds.
16. Data needed to acquire the Owner's insurance.
17. Initial settlement survey and damage report, if required.

K. Application for Payment at Substantial Completion: Following issuance of the Certificate of Substantial Completion, submit an Application for Payment.

1. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

2. Administrative actions and submittals that shall precede or coincide with this application include:

   a. Occupancy permits and similar approvals.
   b. Warranties (guarantees) and maintenance agreements.
   c. Test/adjust/balance records.
   d. Maintenance instructions.
   e. Meter readings.
   f. Startup performance reports.
   g Changeover information related to Owner's occupancy, use, operation, and maintenance.
   h. Final cleaning.

i. Application for reduction of retainage and consent of surety.
j. Advice on shifting insurance coverages.
k. Final progress photographs.
l. List of incomplete Work, recognized as exceptions to Owner's Certificate of Substantial Completion.

L. Final Payment Application: Administrative actions and submittals that must precede or coincide with submittal of the final Application for Payment include the following:

1. Completion of Project closeout requirements.
2. Completion of items specified for completion after Substantial Completion.
3. Ensure that unsettled claims will be settled.
4. Ensure that incomplete Work is not accepted and will be completed without undue delay.
5. Transmittal of required Project construction records to the Owner.
6. Certified property survey.
7. Proof that taxes, fees, and similar obligations were paid.
8. Removal of temporary facilities and services.
9. Removal of surplus materials, rubbish, and similar elements.
10. Change of door locks to Owner's access.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes administrative and supervisory requirements necessary for coordinating construction operations including, but not necessarily limited to, the following:

1. General project coordination procedures.
2. Conservation.
3. Coordination Drawings.
4. Administrative and supervisory personnel.
5. Cleaning and protection.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 1 Section “Field Engineering” specifies procedures for field engineering services, including establishment of benchmarks and control points.
2. Division 1 Section “Project Meetings” for progress meetings, coordination meetings, and preinstallation conferences.
3. Division 1 Section “Submittals” for preparing and submitting the Contractor’s Construction Schedule.
4. Division 1 Section “Materials and Equipment” for coordinating general installation.
5. Division 1 Section “Contract Closeout” for coordinating contract closeout.

1.3 Coordination

A. Coordinate construction operations included in various Sections of these Specifications to assure efficient and orderly installation of each part of the Work. Coordinate construction operations included under different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in the sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to assure maximum accessibility for required maintenance, service, and repair.
3. Make provisions to accommodate items scheduled for later installation.

B. Where necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and attendance at meetings.

1. Prepare similar memoranda for the Owner and separate contractors where coordination of their work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and assure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of schedules.
2. Installation and removal of temporary facilities.
3. Delivery and processing of submittals.
4. Progress meetings.
5. Project closeout activities.

D. Conservation: Coordinate construction operations to assure that operations are carried out with consideration given to conservation of energy, water, and materials.

1. Salvage materials and equipment involved in performance of, but not actually incorporated in, the Work.

1.4 Submittals

A. Coordination Drawings: Prepare coordination drawings where careful coordination is needed for installation of products and materials fabricated by separate entities. Prepare coordination drawings where limited space availability necessitates maximum utilization of space for efficient installation of different components.

1. Show the relationship of components shown on separate Shop Drawings.
2. Indicate required installation sequences.
3. Comply with requirements contained in Section “Submittals.”

B. Staff Names: Within 15 days of commencement of construction operations, submit a list of the Contractor’s principal staff assignments, including the superintendent and other personnel in attendance at the Project Site. Identify individuals and their duties and responsibilities. List their addresses and telephone numbers.

1. Post copies of the list in the Project meeting room, the temporary field office, and each temporary telephone.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 General Coordination Provisions

A. Inspection of Conditions: Require the Installer of each major component to inspect both the substrate and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.

B. Coordinate temporary enclosures with required inspections and tests to minimize the necessity of uncovering completed construction for that purpose.

3.2 Cleaning and Protection

A. Clean and protect construction in progress and adjoining materials in place, during handling and installation. Apply protective covering where required to assure protection from damage or deterioration at Substantial Completion.

B. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to assure operability without damaging effects.

C. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period. Where applicable, such exposures include, but are not limited to, the following:

1. Excessive static or dynamic loading.
2. Excessive internal or external pressures.
3. Excessively high or low temperatures.
4. Thermal shock.
5. Excessively high or low humidity.
6. Air contamination or pollution.
7. Water or ice.
8. Solvents.
9. Chemicals.
10. Light.
11. Radiation.
12. Puncture.
13. Abrasion.
14. Heavy traffic.
15. Soiling, staining, and corrosion.
16. Bacteria.
17. Rodent and insect infestation.
18. Combustion.
19. Electrical current.
20. High-speed operation.
21. Improper lubrication.
22. Unusual wear or other misuse.
23. Contact between incompatible materials.
24. Destructive testing.
25. Misalignment.
26. Excessive weathering.
27. Unprotected storage.
28. Improper shipping or handling.
29. Theft.
30. Vandalism.

END OF SECTION

SECTION 01045 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes administrative and procedural requirements for cutting and patching.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 1 Section “Coordination” for procedures for coordinating cutting and patching with other construction activities.

2. Division 2 Section “Selective Demolition” for demolition of selected portions of the building for alterations.

3. Refer to other Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

   a. Requirements of this Section apply to mechanical and electrical installations. Refer to Division 15 Sections for other requirements and limitations applicable to cutting and patching mechanical and electrical installations.

1.3 Submittals

A. Cutting and Patching Proposal: Submit a proposal describing procedures well in advance of the time cutting and patching will be performed if the Owner requires approval of these procedures before proceeding. Request approval to proceed. Include the following information, as applicable, in the proposal:

1. Describe the extent of cutting and patching required. Show how it will be performed and indicate why it cannot be avoided.

2. Describe anticipated results in terms of changes to existing construction. Include changes to structural elements and operating components as well as changes in the building’s appearance and other significant visual elements.

3. List products to be used and firms or entities that will perform Work.

4. Indicate dates when cutting and patching will be performed.

5. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out-of-service. Indicate how long service will be disrupted.

6. Where cutting and patching involves adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with the original structure.

7. Approval by the Owner to proceed with cutting and patching does not waive the Owner's right to later require complete removal and replacement of unsatisfactory work.

1.4 Quality Assurance

A. Requirements for Structural Work: Do not cut and patch structural elements in a manner that would change their load-carrying capacity or load-deflection ratio.

1. Obtain approval of the cutting and patching proposal before cutting and patching the following structural elements:

   a. Foundation construction.
   b. Bearing and retaining walls.
   c. Structural concrete.
   d. Structural steel.
   e. Lintels.
   f. Timber and primary wood framing.
   g Structural decking.
   h. Stair systems.
   i. Miscellaneous structural metals.
   j. Exterior curtain-wall construction.
   k. Equipment supports.
   l. Piping, ductwork, vessels, and equipment.
   m. Structural systems of special construction in Division 13 Sections.

B. Operational Limitations: Do not cut and patch operating elements or related components in a manner that would result in reducing their capacity to perform as intended. Do not cut and patch operating elements or related components in a manner that would result in increased maintenance or decreased operational life or safety.

1. Obtain approval of the cutting and patching proposal before cutting and patching the following operating elements or safety related systems:

   a. Primary operational systems and equipment.
   b. Air or smoke barriers.
   c. Water, moisture, or vapor barriers.
   d. Membranes and flashings.
   e. Fire protection systems.
   f. Noise and vibration control elements and systems.
   g. Control systems.
   h. Communication systems.
   i. Conveying systems.
   j. Electrical wiring systems.
   k. Operating systems of special construction in Division 13 Sections.

C. Visual Requirements: Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in the Owner's opinion, reduce the building's aesthetic qualities. Do not cut and patch construction in a manner that would result in visual evidence of cutting and patching. Remove and replace construction cut and patched in a visually unsatisfactory manner.

1. If possible retain the original Installer or fabricator to cut and patch the exposed Work listed below. If it is impossible to engage the original Installer or fabricator, engage another recognized experienced and specialized firm.

   a. Processed concrete finishes.
   b. Stonework and stone masonry.
   c. Ornamental metal.
   d. Matched-veneer woodwork.
   e. Preformed metal panels.
   f. Firestopping.
   g. Window wall system.
   h. Stucco and ornamental plaster.
   i. Acoustical ceilings.
   j. Terrazzo.
   k. Finished wood flooring.
   l. Fluid-applied flooring.
   m. Carpeting.
   n. Aggregate wall coating.
   o. Wall covering.
   p. Swimming pool finishes.
   q. HVAC enclosures, cabinets, or covers.

1.5 Warranty

A. Existing Warranties: Replace, patch, and repair material and surfaces cut or damaged by methods and with materials in such a manner as not to void any warranties required or existing.

PART 2 - PRODUCTS

2.1 Materials, General

A. Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible if identical materials are unavailable or cannot be used. Use materials whose installed performance will equal or surpass that of existing materials.

B. Plaster: Comply with ASTM C 842.

   1. Base Coat: Ready-mixed, sand aggregate gypsum plaster base.

   2. Finish Coat: Ready-mixed gypsum finish plaster.

PART 3 - EXECUTION

3.1 Inspection

A. Examine surfaces to be cut and patched and conditions under which cutting and patching is to be performed before cutting. If unsafe or unsatisfactory conditions are encountered, take corrective action before proceeding.

   1. Before proceeding, meet at the Project Site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

3.2 Preparation

A. Temporary Support: Provide temporary support of work to be cut.

B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations.

C. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Avoid cutting existing pipe, conduit, or ductwork serving the building but scheduled to be removed or relocated until provisions have been made to bypass them.

3.3 Performance

A. General: Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay.

1. Cut existing construction to provide for installation of other components or performance of other construction activities and the subsequent fitting and patching required to restore surfaces to their original condition.

B. Cutting: Cut existing construction using methods least likely to damage elements retained or adjoining construction. Where possible, review proposed procedures with the original Installer; comply with the original Installer's recommendations.

1. In general, where cutting, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.

2. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces.

3. Cut through concrete and masonry using a cutting machine, such as a Carborundum saw or a diamond-core drill.

4. Comply with requirements of applicable Division 2 Sections where cutting and patching requires excavating and backfilling.

5. Where services are required to be removed, relocated, or abandoned, by-pass utility services, such as pipe or conduit, before cutting. Cut-off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after by-passing and cutting.

C. Patching: Patch with durable seams that are as invisible as possible. Comply with specified tolerances.

1. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.

2. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

3. Where removing walls or partitions extends one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform color and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

   a. Where patching occurs in a smooth painted surface, extend final paint coat over entire unbroken surface containing the patch after the area has received primer and second coat.

4. Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

D. Plaster Installation: Comply with manufacturer's instructions and install thickness and coats as indicated.

1. Unless otherwise indicated, provide 3-coat work.

2. Finish gypsum plaster to match existing adjacent surfaces. Sand lightly to remove trowel marks and arises.

3. Cut, patch, point-up, and repair plaster to accommodate other construction.

3.4 Cleaning

A. Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar items. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

END OF SECTION

Section 01098 - Codes, Regulations, Standards and Submittals

PART 1 – GENERAL

1.1 Related Documents

A. Building system drawings and general provisions of Contract, including General and Supplementary Conditions and other Division-1 Specification Sections, apply to this section.

1.2 Definitions

A. MIT has engaged a construction management company to act as its agent and representative for the completion of this project. For the remainder of this document, the construction management company will be referred to as the “Construction Manager”.

B. MIT has engaged an environmental consulting firm to act as its representative for environmental assessment activities and related technical services. For the remainder of this document, the environmental consulting firm will be referred to as the “Environmental Consultant”.

1.3 Summary

A. This section identifies notifications, permits, licenses, training, and documentation, which are required by Federal, state and local government regulations.

1. Contractors are responsible for:

- Obtaining and maintaining all permits and licenses relevant to environmental, health, safety and demolition regulations.
- Submitting all environmental, health and safety notifications to the appropriate cognizant government agencies in a timely manner.
- Training employees in relevant environmental, health and safety issues.
- Creating and maintaining environmental health and safety records and documents.
- Developing and implementing required environmental, health and safety written programs and policies to comply with all applicable regulatory requirements and to ensure the successful completion of their work on this project.

2. Contractors will provide copies of all environmental, health and safety permits, licenses, and notifications to the Construction Manager. In addition, they will provide assurances that all relevant training has been provided and that required documentation is on file and available to the Construction Manager.

   a. The purpose of these submittals is to assure MIT and/or the Construction Manager thatlegally required actions have been properly accomplished.
   b. Neither MIT nor the Construction Manager, nor the Environmental Constultant will review or certify the accuracy or adequacy of any documents prepared by contractors pursuant to government regulations.

1.4 Codes, Regulations and Standards

A. General Applicability of Codes, Regulations and Standards: Except to the extent that more explicit or more stringent requirements are written directly into the Contract Documents, all applicable codes and regulations have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the Contract Documents, or as if published copies are bound herewith.

B. Contractor Responsibility: The Contractor shall assume full responsibility and liability for the compliance with all applicable Federal, state and local regulations pertaining to work practices, hauling, disposal, and protection of workers and visitors to the site, and persons occupying areas adjacent to and in the vicinity of the job site. The Contractor is responsible for providing medical examinations and maintaining medical records of personnel as required by the applicable Federal, state and local regulations. The Contractor shall hold MIT, Construction Manager, Environmental Consultant and any third party harmless for the Contractor's, Contractor's employees or subcontractor's failure to comply with any applicable work, hauling, disposal, environmental, safety, health and/or other applicable regulation.

C. Federal Requirements: which are relevant to environmental, health and safety, and hauling and disposal of hazardous waste materials include but are not limited to the following:

1. OSHA: U.S. Department of Labor, Occupational Safety and Health Administration, (OSHA).

   - Asbestos; 29 CFR 1910.1001 and 29 CFR 1926.1101.
   - Respiratory Protection; 29 CFR 1910.134 and 29 CFR 1926.103.
   - Personal Protective Equipment; 29 CFR 1910 Subpart I and 29 CFR 1926 Subpart E.
   - Access to Employee Exposure and Medical Records; 29 CFR 1926.33.
   - Hazard Communication; 29 CFR 1910.1200 and 29 CFR 1926.59.
   - Specifications for Accident Prevention Signs and Tags; 29 CFR 1910.145.
   - Permit Required Confined Space; 29 CFR 1910.146.
   - General Safety and Health Provisions; 29 CFR 1926 Subpart C.
   - Lead; 29 CFR 1926.62.

2. DOT: U. S. Department of Transportation (DOT), including but not limited to:

   - Hazardous Materials Regulations; 49 CFR Parts 100-185.

3. EPA: U. S. Environmental Protection Agency (EPA), including but not limited to:

   - Asbestos Hazard Emergency Response Act (AHERA) Regulation; 40 CFR Part 763.
   - National Emission Standard for Hazardous Air Pollutants (NESHAP); 40 CFR Part 61.
     National Emission Standard for Asbestos; 40 CFR Part 61 Subpart M.
   - Toxic Substances Control Act (TSCA) 40 CFR Part 761 – Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, And Use Prohibitions.

4. State Requirements: which govern the hauling and disposal of asbestos waste materials include but are not limited to the following:

   - 310 CMR 4.00 Timely Action Schedule and Fees.
   - 310 CMR 7.00 Air Pollution Control.
   - 310 CMR 30.0000 Hazardous Waste Regulations.
   - 310 CMR 19.00 Solid Waste Management.

5. Local Requirements: which govern asbestos abatement work or hauling and disposal of asbestos waste materials include but are not limited to the following:

   - City of Cambridge Municipal Code Section 8.61 –Asbestos Protection Ordinance.

6. The above lists are not all-inclusive and are provided for general reference purposes only.

The Contractor and all of its subcontractors are responsible to comply with regulatory requirements as deemed applicable during completion of this project.

PART 2 – NOTICES, LISCENSES AND PERMITS

2.1 Notices

A. A copy of the Commonwealth of Massachusetts Asbestos Abatement Notification Package including the "Asbestos Notification Form ANF-001" is presented at the end of this section.

B. The Contractor will postmark or deliver written notification as required by the Massachusetts Department of Environmental Protection (DEP). Notification must be made to the DEP at least ten (10) working days prior to beginning any work on ACBM.

Commonwealth of Massachusetts
Asbestos Program
P.O. Box 120087
Boston, MA 02112-0087
(617) 292-5500

2.2 Permits

A. Permits: All asbestos containing waste is to be transported by an entity maintaining any and all applicable permits and/or licenses issued by specifically for ACBM, as required for transporting of waste ACBM to a disposal site.

B. Contractor is responsible for obtaining any demolition, building, renovation or other permits, and for paying application fees, if any, where required by State or local jurisdictions.

2.3 Licenses

A. Licenses: The Contractor will maintain current licenses as required by applicable state or local jurisdictions for the removal, transporting, disposal or other regulated activity relative to the work of this contract.

2.4 Posting and Filing of Regulations

A. Posting and Filing of Regulations: The Contractor will post all notices required by applicable Federal, state and local regulations. Maintain two (2) copies of applicable Federal, state and local regulations and standards. Maintain one (1) copy of each at the Contractor's job site and in the Constructions Manager's office.

PART 3 – SUBMITTALS

3.1 Regulatory Submittals

A. All submittals noted in this section are provided to the Construction Manager by the Contractor for record purposes only to assure MIT that the Contractor is complying with relevant laws and regulations. The Construction Manager, the Environmental Consultant, and MIT will not review any submittals for completeness or accuracy or indicate approval or disapproval.

B. The Contractor will submit the following to the Construction Manager before commencing any work requiring such documentation.

1. Permits, Licenses, and Certificates: For MIT's records, the Contractor will submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents, correspondence, and records established in conjunction with compliance with standards and regulations bearing upon performance of the work including, but not limited to:

   - Notices: Submit notices required by Federal, state and local regulations together with proof of timely transmittal to the agency requiring the notice.
   - Permits: Submit copies of current valid permits required by Federal, state and local regulations.
   - Licenses: Submit copies of all Federal, state and local licenses and permits necessary to carry out the work of this contract.

3.2 Training Programs

A. Several environmental, health and safety laws and regulations require that certain employees be trained either in specified ways or generally in workplace safety issues. The Contractor will provide the Construction Manager with written assurances that all workers including temporary and contract workers on the site have received appropriate training before their work commences.

1. The following is a list of some of the required training programs:

   - OSHA Safety Training and Education for Construction: 29 CFR 1926.21
   - OSHA Lead Standard for Construction: 29 CFR 1926.62(l)
   - OSHA Asbestos Standard for Construction 29 CFR 1926.1101(k)(9)
   - OSHA Respirator Standard 29 CFR 1910.134(k)
   - OSHA Hazard Communication Standard 29 CFR 1926.59

3.3 Recordkeeping

A. Several environmental, health and safety laws and regulations require that records be kept of certain types of information. The Contractor will provide the following records, when applicable, to the Construction Manager before commencing work and/or during completion of the work, as new data are generated:

   - Blood lead measurements in accordance with 29 CFR 1926.62(j) and other applicable regulations on employees exposed to lead will be provided within one month of the receipt of laboratory reports. The data provided shall include the names and job titles of the employees who were tested.
   - Material Safety Data Sheets (MSDSs) for chemicals used on the project will be provided before the use of the chemicals begin.
   - The OSHA log of employee injuries and illnesses (OSHA Form 200) will be provided quarterly and within one month of the completion of the contract.
   - Analytical data, including Toxicity Characteristic Leaching Procedure (TCLP) test results, used for the identification and classification of hazardous waste will be provided within one month after laboratory results have been received.
   - Initial air lead level results must be submitted to the Construction Manager immediately upon receipt of analytical results in order to determine if a particular work activity can be performed without the use of respiratory protection per OSHA 29 CFR 1926.62.

END OF SECTION

SECTION 01101 - SUMMARY OF WORK

PART 1 – GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. Other sections of the project manual that apply to this section are:

- 01098 – Codes, Regulations and Standards
- 01421 – Definitions and Acronyms
- 01701 – Control of Contamination
- 01703 – Hazard Communication and Chemical Handling
- 01704 – Molds, Fungi, Animal, Bird and Bat Droppings
- 01705 – Physical Hazards in MIT Facilities
- 01706 – Construction Site Safety Issues
- 02083 – Discovery of Suspect Asbestos Containing Building Materials
- 02081 – Work on Surfaces Painted with Lead Based Paint

1.2 Definitions

A. MIT has engaged a construction management company to act as its agent and representative for the completion of this project. For the remainder of this document, the construction management company will be referred to as the "Construction Manager".

B. MIT has engaged an environmental consulting firm to act as its representative for environmental assessment activities and related technical services. For the remainder of this document, the environmental consulting firm will be referred to as the "Environmental Consultant".

C. HEPA Vacuum Cleaner – A vacuum cleaner, wet-dry type, equipped with High Efficiency Particulate Air Filter. Particulate air filtration capable of filtering 0.3 micron particles with 99.97% efficiency.

D. HEPA Filtration – High efficiency particulate air filtration capable of filtering 0.3 micron particles with 99.97% efficiency.

E. Coring: To produce a uniform diameter hole in a building surface. (Note: Will be completed by a licensed specialty abatement contractor (i.e., drilling/coring for risers, conduits, etc.)).

F. Drilling: To make a hole in a building surface with the use of a drill. (Note: Will be completed by a licensed specialty abatement contractor (i.e., drilling for risers, conduits, etc.)).

G. Anchoring: To affix wall anchors, support screws and or fasteners into a building surface. A pilot hole must first be pre-drilled into the building surface before the anchoring device is secured. This activity does not require the use of a "shrouded tool" or personal protective equipment (PPE).

H. Direct Anchoring: To affix wall anchors, support screws and or fasteners to a building surface without the prior drilling of pilot holes. This activity does not require the use of a "shrouded tool" or personal protective equipment (PPE).

1.3 Work Covered By Contract Documents

A. This section and sections referenced in Part 1.1.2 above, describe requirements and procedures for controlling potential contamination by hazardous and non-hazardous materials during the completion of the Fire Safety Renewal Project.

1. Project Location: Massachusetts Institute of Technology (MIT), Cambridge, MA Campus.

2. Owner: Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139. For the remainder of this document, the Owner will be referred to as "MIT".

B. Dated Contract Documents were prepared for the Project by Fay, Spofford and Thorndike, Inc., 5 Burlington Woods, Burlington, MA 01803 and FIREPRO, Inc., 100 Burtt Road, Andover, MA 01810-5920.

C. The Work: During surveys of the project site, the presence of lead, asbestos and other hazardous building materials (i.e., Polychlorinated Biphenyls (PCBs)) were identified and located in certain areas. In an effort to help assure that the work of the project does not result in contamination of MIT facilities and that all work is conducted in accordance with relevant Federal, state and local laws and regulations, these project specifications must be followed by all contractors and subcontractors involved in the project. In addition, review procedures are identified to confirm that work is being performed in accordance with specifications. This includes visual observations as well as monitoring of airborne contaminant concentrations and other media.

1.4 Work Under Other Contracts

A. MIT has awarded separate contracts for performance of certain preconstruction and construction operations at the site. Certain operations will be conducted simultaneously with work under this Contract. One such contract includes the following:

1. A separate contract has been awarded to Mabbett & Associates, Inc. (M&A) to act as the Environmental Consultant. In addition to providing general guidance regarding environmental compliance, M&A will serve in the following capacity in accordance with the identified Massachusetts regulations:

   · Asbestos Management Planner, in accordance with 453 CMR 6.00.

B. M&A is not responsible for the development and/or implementation of any environmental, health and safety policies, programs, protocols, etc. for use by contractors during the completion of any on-site construction and related activities. All contractors and sub-contractors are directly and solely responsible to ensure that their work is completed in accordance with applicable regulatory requirements. M&A will liaison directly with the Construction Manager during the project.

1.5 Hazardous Building Materials

A. The Work of this project involves activities that will disturb building components such as walls, floors and ceilings that have a high probability of containing asbestos (asbestos containing building materials (ACBM) or presumed asbestos containing building materials (PACBM)) or lead (lead based paint (LBP)). The locations and types of building components that are known or can be presumed to contain lead and/or asbestos present at the job site are set forth in the reports prepared by the Environmental Consultant. The Construction Manager can provide these materials. If a material has been confirmed by analysis to contain asbestos, it will be referred to as an asbestos containing building material (ACBM). If any other materials are found which are suspected of containing asbestos or lead, stop all work with those material, notify the Construction

Manager as soon as possible (refer to Section 02083 – Discovery of Suspect Asbestos Containing Building Materials) and proceed with the work in accordance with his/her instructions.

B. The disturbance or dislocation of ACBM and LBP may cause asbestos fibers or lead containing dust to potentially release into the building's atmosphere, thereby creating a potential health risk to workers and building occupants. During project meetings, contractors and their supervisors will be apprised of the risks and of proper work procedures that must be followed. Contractors are responsible for informing and training their own employees (including temporary and contract employees), subcontractors and consultants in the locations of hazardous building materials and the proper work procedures.

C. Where in the performance of the work, workers, supervisory personnel, subcontractors or consultants encounter, disturb or otherwise function in the immediate vicinity of any identified hazardous building material, they must take appropriate continuous measures as necessary, to protect all building occupants from the risk of exposure. Such measures shall include the procedures and methods described herein, and compliance with regulations of applicable Federal, state and local agencies.

D. Based on data collected to-date, it appears that ACBM and LBP issues can be reasonably controlled by following the project technical specifications contained in this Project Manual. Preconstruction activities by a licensed specialty abatement contractor will help to reduce the likelihood of ACBM and LBP issues arising during general construction by other tradesmen. All such personnel however, must be cognizant of the potential issues and conduct themselves accordingly.

1.6 Potential Health and Safety Risks of this Project

A. Hazardous materials may be present in certain building components, may be used in work areas by contractors or may have been used in existing MIT systems. Safety hazards may also be created by contractors on this project or by existing MIT activities. Procedures are provided in other sections of this Project Manual to minimize the exposure of project workers, MIT students and personnel, and the general public to such safety and health hazards and to help assure that all relevant environmental regulations are complied with during the project.

1.7 Contractor Use of Premises

A. General: During the construction period the Contractor will have full use of the premises for construction operations, including use of the site. The Contractor's use of the premises is limited only by MIT's right to perform work or to retain other contractors on portions of the Project.

1. Driveways and Entrances: Contractor will keep driveways and entrances serving the premises clear and available to MIT, MIT employees and emergency vehicles at all times. Contractor will not use these areas for parking or storage of materials. Contractor will schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

2. Use of Existing Elevators: Contractor will provide protective pads for the elevator car and other appropriate protective measures for the car, entrance doors and frames.

1.8 Environmental, Health And Safety Observation By The Owner

A. MIT has contracted with the Environmental Consultant to perform limited observation of compliance as requested by MIT, with the environmental terms of the contract and these specifications. This activity will include visual observations and measurements of airborne contaminant concentrations.

1. The Environmental Consultant will observe general compliance with relevant environmental regulations including those concerned with the disposal of regulated wastes, both hazardous and non-hazardous.

2. MIT does not accept any responsibility for Contractor compliance with the Occupational Health and Safety Administration (OSHA) and Massachusetts regulations as they refer to the safety and health of Contractor employees. The Construction Manager may bring worker safety and health hazards that may be observed during the project to the attention of the Contractor.

3. If the Environmental Consultant observes conditions which have the potential for endangering the health or safety of MIT employees, faculty, staff, visitors or contractors, or may expose MIT to potential litigation, he/she will bring such conditions to the attention of the Construction Manager and MIT. The Construction Manager may require that work be stopped until the conditions have been corrected.

4. Air monitoring will be periodically conducted to confirm that dust control techniques are preventing airborne contamination in excess of the exposure limits listed in Section 1.9.3 and also to verify that excessive amounts of lead, asbestos and general construction dust do not settle onto environmental surfaces.

B. Air monitoring required by OSHA for Contractor employees is the direct responsibility of the Contractor and is not covered in any section of this Project Manual.

1.9 Air Sampling

A. Methods include, but are not limited to:

- Asbestos: NIOSH 7400 or OSHA ID-160
- Lead: NIOSH 7082 or OSHA ID-121
- Particulates Not Otherwise Regulated (total): NIOSH 0500
- Other Substances: To be determined by the Environmental Consultant

B. Protocol includes, but is not limited to:

- Samples will be collected at times and locations selected by the Environmental Consultant.

C. Exposure Limits are based on an eight (8) hour time weighted average (TWA) unless otherwise noted.

- Asbestos: 0.1 fibers per cubic centimeter (f/cc) of air.
  - o f/cc excursion level (30 minutes).
- Lead: 0.05 mg/m^3.

  Particulates Not Otherwise Regulated (total): 15 mg/m^3.

D. Exceedance of Exposure Limits

1. If any airborne concentration exceeds the exposure limit, the Environmental Consultant, in consultation with the Construction Manager, will identify the likely cause of the exceedance. The Contractor, with the approval of the Construction Manager, will implement a corrective action as necessary that will bring airborne concentrations below the exposure limits. The costs of corrective actions will be borne by the contractor and may not be charged back to MIT.

B. A complete record of all air monitoring and results will be furnished to MIT and the Construction Manager.

C. MIT will not perform air monitoring for the Contractor to meet Contractor's OSHA requirements for personal sampling or for drilling any other purpose.

PART 2 – PRODUCTS

2.1 General

A. All tasks involving coring and drilling into building surfaces, whether or not the surfaces contain lead based paint elsewhere will use tools equipped with close fitting local exhaust hoods ("shrouded tool") served by a HEPA vacuum cleaner. This provision primarily pertains to pre-construction activities completed by a licensed specialty abatement contractor who shall drill holes for pipe and conduit runs through certain floors and walls. Refer to Section 02081 – Work Surfaces on Painted with Lead Based Paint – Part 2 Execution. It is not anticipated that other tradesmen will be required to utilize any special environmental, health and safety precautions during completion of the project, other than as outlined herein. If such instances do arise, the Construction Manager with input from the Environmental Consultant shall advise regarding an appropriate course of action.

B. Anchoring or Direct Anchoring tasks will not require the use of "shrouded tools" unless a change in the anticipated working conditions occurs.

END OF SECTION

SECTION 01200 - PROJECT MEETINGS

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section specifies administrative and procedural requirements for project meetings, including, but not limited to, the following:

1. Preconstruction conferences.
2. Preinstallation conferences.
3. Progress meetings.
4. Coordination meetings.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 1 Section “Coordination” for procedures for coordinating project meetings with other construction activities.

2. Division 1 Section “Submittals” for submitting the Contractor’s Construction Schedule.

1.3 Preconstruction Conference

A. Schedule a preconstruction conference before starting construction, at a time convenient to the Owner but no later than 15 days after execution of the Agreement. Hold the conference at the Project Site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.

B. Attendees: Authorized representatives of the Owner and their consultants; the Contractor and its superintendent; major subcontractors; manufacturers; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with the Project and authorized to conclude matters relating to the Work.

C. Agenda: Discuss items of significance that could affect progress, including the following:

1. Tentative construction schedule.
2. Critical work sequencing.
3. Designation and contact information of responsible personnel.
4. Procedures for processing field decisions and Change Orders.
5. Procedures for processing Applications for Payment.
6. Distribution of Contract Documents.
7. Submittal of Shop Drawings, Product Data, and Samples.
8. Preparation of record documents.
9. Use of the premises.
10. Parking availability.
11. Office, work, and storage areas.
12. Equipment deliveries and priorities.
13. Safety procedures.

14. First aid.
15. Security.
16. Housekeeping.
17. Working hours.

1.4 Preinstallation Conferences

A. Conduct a preinstallation conference at the Project Site before each construction activity that requires coordination with other construction.

B. Attendees: The Installer and representatives of manufacturers and fabricators involved in or affected by the installation, and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise the Owner of scheduled meeting dates.

1. Review the progress of other construction activities and preparations for the particular activity under consideration at each preinstallation conference, including requirements for the following:

    a. Contract Documents.
    b. Options.
    c. Related Change Orders.
    d. Purchases.
    e. Deliveries.
    f. Shop Drawings, Product Data, and quality-control samples.
    g. Review of mockups.
    h. Possible conflicts.
    i. Compatibility problems.
    j. Time schedules.
    k. Weather limitations.
    l. Manufacturer's recommendations.
    m. Warranty requirements.
    n. Compatibility of materials.
    o. Acceptability of substrates.
    p. Temporary facilities.
    q. Space and access limitations.
    r. Governing regulations.
    s. Safety.
    t. Inspecting and testing requirements.
    u. Required performance results.
    v. Recording requirements.
    w. Protection.

2. Record significant discussions and agreements and disagreements of each conference, and the approved schedule. Promptly distribute the record of the meeting to everyone concerned, including the Owner.

3. Do not proceed with the installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of Work and reconvene the conference at the earliest feasible date.

1.5 Progress Meetings

A. Conduct progress meetings at the Project Site at regular intervals. Notify the Owner of scheduled meeting dates. Coordinate dates of meetings with preparation of the payment request.

B. Attendees: In addition to representatives of the Owner, each subcontractor, supplier, or other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with the Project and authorized to conclude matters relating to the Work.

C. Agenda: Review and correct or approve minutes of the previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to the status of the Project.

1. Contractor's Construction Schedule: Review progress since the last meeting. Determine where each activity is in relation to the Contractor's Construction Schedule, whether on time or ahead or behind schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to insure that current and subsequent activities will be completed within the Contract Time.

2. Review the present and future needs of each entity present, including the following:

   a. Interface requirements.
   b. Time.
   c. Sequences.
   d. Status of submittals.
   e. Deliveries.
   f. Off-site fabrication problems.
   g. Access.
   h. Site utilization.
   i. Temporary facilities and services.
   j. Hours of work.
   k. Hazards and risks.
   l. Housekeeping.
   m. Quality and work standards.
   n. Pending Change Orders and Substitutions.
   o. Documentation of information for payment requests.

D. Reporting: No later than 3 days after each meeting, distribute minutes of the meeting to each party present and to parties who should have been present. Include a brief summary, in narrative form, of progress since the previous meeting and report.

1. Schedule Updating: Revise the Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue the revised schedule concurrently with the report of each meeting.

1.6 Coordination Meetings

A. Conduct project coordination meetings at regular intervals convenient for all parties involved. Project coordination meetings are in addition to specific meetings held for other purposes, such as regular progress meetings and special preinstallation meetings.

B. Request representation at each meeting by every party currently involved in coordination or planning for the construction activities involved.

C. Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 01250 - CONTRACT MODIFICATION PROCEDURES

1.1 GENERAL

A. Minor Changes in the Work: Owner will issue supplemental instructions authorizing Minor Changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.

B. Owner-Initiated Proposal Requests: Owner will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Proposal Requests are for information only. They are not to be considered as instructions either to stop work in progress or to execute the proposed change.

2. Within 20 days after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

b. Indicate taxes, delivery charges, equipment rental, and amounts of trade discounts.

c. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

C. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

3. Indicate taxes, delivery charges, equipment rental, and amounts of trade discounts.

4. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

5. Comply with requirements in Division 1 Section "Product Requirements" if the proposed change requires substitution of one product or system for product or system specified.

D. Proposal Request Form: Use AIA Document G709 for Proposal Requests.

E. Proposal Request Form: For Change Order proposals, use forms provided by Owner.

F. Allowance Adjustment: Base each Change Order proposal on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place. Allow for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.

1. Include installation costs only where indicated as part of the allowance.

2. Prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.

3. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.

G. Submit claims for increased costs because of a change in the allowance described in the Contract Documents, whether for the Purchase Order amount or Contractor's handling, labor, installation, overhead, and profit. Submit claims within 21 days of receipt of the Change Order or Construction Change Directive authorizing work to proceed. Owner will reject claims submitted later than 21 days after such authorization.

1. Contractor's or subcontractor's indirect expense will not e included in the Change Order cost amount unless the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.

2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

H. Change Order Procedures: On Owner's approval of a Proposal Request, Owner will issue a Change Order for signatures of Owner and Contractor.

I. Construction Change Directive: Owner may issue a Construction Change Directive. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

2. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.

a. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

1.2 PRODUCTS (Not Used)

1.3 EXECUTION (Not Used)

END OF SECTION

SECTION 01300 - SUBMITTALS

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes administrative and procedural requirements for submittals required for performance of the Work, including the following:

1. Contractor's construction schedule.
2. Submittal schedule.
3. Daily construction reports.
4. Shop Drawings.
5. Product Data.
6. Samples.
7. Quality assurance submittals.

B. Administrative Submittals: Refer to other Division 1 Sections and other Contract Documents for requirements for administrative submittals. Such submittals include, but are not limited to, the following:

1. Permits.
2. Applications for Payment.
3. Performance and payment bonds.
4. Insurance certificates.
5. List of subcontractors.

C. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 1 Section "Applications for Payment" specifies requirements for submittal of the Schedule of Values.

2. Division 1 Section "Coordination" specifies requirements governing preparation and submittal of required Coordination Drawings.

3. Division 1 Section "Project Meetings" specifies requirements for submittal and distribution of meeting and conference minutes.

4. Division 1 Section "Construction Photographs" specifies requirements for submittal of periodic construction photographs.

5. Division 1 Section "Quality Control" specifies requirements for submittal of inspection and test reports.

6. Division 1 Section "Contract Closeout" specifies requirements for submittal of Project Record Documents and warranties at project closeout.

1.3 Definitions

A. Coordination Drawings show the relationship and integration of different construction elements that require careful coordination during fabrication or installation to fit in the space provided or to function as intended.

1. Preparation of Coordination Drawings is specified in Division 1 Section “Coordination” and may include components previously shown in detail on Shop Drawings or Product Data.

B. Field samples are full-size physical examples erected on-site to illustrate finishes, coatings, or finish materials. Field samples are used to establish the standard by which the Work will be judged.

C. Mockups are full-size assemblies for review of construction, coordination, testing, or operation; they are not Samples.

1.4 Submittal Procedures

A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit a minimum of five (5) copies of each submittal sufficiently in advance of performance of related construction activities to avoid delay.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.

   a. The Owner reserves the right to withhold action on a submittal requiring coordination with other submittals until all related submittals are received.

3. Processing: To avoid the need to delay installation as a result of the time required to process submittals, allow sufficient time for submittal review, including time for resubmittals.

   a. Allow 2 weeks for initial review. Allow additional time if the Owner must delay processing to permit coordination with subsequent submittals.

   b. If an intermediate submittal is necessary, process the same as the initial submittal.

   c. Allow 2 weeks for reprocessing each submittal.

   d. No extension of Contract Time will be authorized because of failure to transmit submittals to the Owner sufficiently in advance of the Work to permit processing.

B. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.

1. Provide a space approximately 4 by 5 inches (100 by 125 mm) on the label or beside the title block on Shop Drawings to record the Contractor’s review and approval markings and the action taken.

2. Include the following information on the label for processing and recording action taken.

   a. Project name.
   b. Date.
   c. Name and address of the Owner.
   d. Name and address of the Contractor.
   e. Name and address of the subcontractor.
   f. Name and address of the supplier.
   g. Name of the manufacturer.
   h. Number and title of appropriate Specification Section.
   i. Drawing number and detail references, as appropriate.

C. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from the Contractor to the Owner using a transmittal form. The Owner will not accept submittals received from sources other than the Contractor.

1. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

2. Transmittal Form: Use AIA Document G810.

1.5 Contractor's Construction Schedule

A. Bar-Chart Schedule: Prepare a fully developed, horizontal bar-chart-type, contractor's construction schedule. Submit within 30 days after the date established for "Commencement of the Work."

1. Provide a separate time bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week. Use the same breakdown of units of the Work as indicated in the "Schedule of Values."

2. Within each time bar, indicate estimated completion percentage in 10 percent increments. As Work progresses, place a contrasting mark in each bar to indicate Actual Completion.

3. Prepare the schedule on a sheet, or series of sheets, of stable transparency, or other reproducible media, of sufficient width to show data for the entire construction period.

4. Secure time commitments for performing critical elements of the Work from parties involved. Coordinate each element on the schedule with other construction activities; include minor elements involved in the sequence of the Work. Show each activity in proper sequence. Indicate graphically the sequences necessary for completion of related portions of the Work.

5. Coordinate the Contractor's Construction Schedule with the Schedule of Values, list of subcontracts, Submittal Schedule, progress reports, payment requests, and other schedules.

6. Indicate completion in advance of the date established for Substantial Completion. Indicate Substantial Completion on the schedule to allow time for the Owner's procedures necessary for certification of Substantial Completion.

B. Phasing: On the schedule, show how requirements for phased completion to permit Work by separate Contractors and partial occupancy by the Owner affect the sequence of Work.

C. Work Stages: Indicate important stages of construction for each major portion of the Work, including submittal review, testing, and installation.

D. Area Separations: Provide a separate time bar to identify each major construction area for each major portion of the Work. Indicate where each element in an area must be sequenced or integrated with other activities.

E. Cost Correlation: At the head of the schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of Work performed as of the dates used for preparation of payment requests.

1. Refer to Division 1 Section “Applications for Payment” for cost reporting and payment procedures.

F. Distribution: Following response to the initial submittal, print and distribute copies to the Owner, subcontractors, and other parties required to comply with scheduled dates. Post copies in the Project meeting room and temporary field office.

1. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.

G. Schedule Updating: Revise the schedule after each meeting, event, or activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting.

1.6 submittal Schedule

A. After development and acceptance of the Contractor’s Construction Schedule, prepare a complete schedule of submittals. Submit the schedule within 10 days of the date required for submittal of the Contractor’s Construction Schedule.

1. Coordinate Submittal Schedule with the list of subcontracts, Schedule of Values, and the list of products as well as the Contractor’s Construction Schedule.

2. Prepare the schedule in chronological order. Provide the following information:

   a. Scheduled date for the first submittal.
   b. Related Section number.
   c. Submittal category (Shop Drawings, Product Data, or Samples).
   d. Name of the subcontractor.
   e. Description of the part of the Work covered.
   f. Scheduled date for resubmittal.
   g. Scheduled date for the Owner’s final release or approval.

B. Distribution: Following response to the initial submittal, print and distribute copies to the Owner, subcontractors, and other parties required to comply with submittal dates indicated. Post copies in the Project meeting room and field office.

C. Schedule Updating: Revise the schedule after each meeting or activity where revisions have been recognized or made. Issue the updated schedule concurrently with the report of each meeting.

1.7 Daily Construction Reports

A. Prepare a daily construction report recording the following information concerning events at the site, and submit duplicate copies to the Owner at weekly intervals:

1. List of subcontractors at the site.
2. Approximate count of personnel at the site.
3. High and low temperatures, general weather conditions.
4. Accidents and unusual events.
5. Meetings and significant decisions.
6. Stoppages, delays, shortages, and losses.
7. Meter readings and similar recordings.
8. Emergency procedures.
9. Orders and requests of governing authorities.
10. Change Orders received, implemented.
11. Services connected, disconnected.
12. Equipment or system tests and startups.
13. Partial Completions, occupancies.
14. Substantial Completions authorized.

1.8 Shop Drawings

A. Submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not a Shop Drawing.

B. Shop Drawings include fabrication and installation Drawings, setting diagrams, schedules, patterns, templates and similar Drawings. Include the following information:

1. Dimensions.

2. Identification of products and materials included by sheet and detail number.

3. Compliance with specified standards.

4. Notation of coordination requirements.

5. Notation of dimensions established by field measurement.

6. Sheet Size: Except for templates, patterns and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm) but no larger than 36 by 48 inches (890 by 1220 mm).

7. Initial Submittal: Submit one correctable, translucent, reproducible print and one blue- or black-line print for the Owner's review. The Owner will return the reproducible print.

8. Initial Submittal: Submit 2 blue- or black-line prints for the Owner's review. The Owner will return one print.

9. Final Submittal: Submit 3 blue- or black-line prints; submit 5 prints where required for maintenance manuals. The Owner will retain 2 prints and return the remainder.

10. Final Submittal: Submit 3 blue- or black-line prints and 2 additional prints where required for maintenance manuals, plus the number of prints needed by the Owner for distribution. The Owner will retain 2 prints and return the remainder.

    a. One of the prints returned shall be marked up and maintained as a “Record Document.”

11. Do not use Shop Drawings without an appropriate final stamp indicating action taken.

1.9 Product Data

A. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information, such as manufacturer’s installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.

1. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products that are not required, mark copies to indicate the applicable information. Include the following information:

    a. Manufacturer’s printed recommendations.
    b. Compliance with trade association standards.
    c. Compliance with recognized testing agency standards.
    d. Application of testing agency labels and seals.
    e. Notation of dimensions verified by field measurement.
    f. Notation of coordination requirements.

2. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.

3. Preliminary Submittal: Submit a preliminary single copy of Product Data where selection of options is required.

4. Submittals: Submit 2 copies of each required submittal; submit 4 copies where required for maintenance manuals. The Owner will retain one and will return the other marked with action taken and corrections or modifications required.

    a. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.

5. Distribution: Furnish copies of final submittal to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms.

    a. Do not proceed with installation until a copy of Product Data is in the Installer’s possession.

    b. Do not permit use of unmarked copies of Product Data in connection with construction.

1.10 Samples

A. Submit full-size, fully fabricated Samples cured and finished as specified and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers of materials, color range sets, and swatches showing color, texture, and pattern.

1. Mount or display Samples in the manner to facilitate review of qualities indicated. Prepare Samples to match the Owner's sample. Include the following:

   a. Specification Section number and reference.
   b. Generic description of the Sample.
   c. Sample source.
   d. Product name or name of the manufacturer.
   e. Compliance with recognized standards.
   f. Availability and delivery time.

2. Submit Samples for review of size, kind, color, pattern, and texture. Submit Samples for a final check of these characteristics with other elements and a comparison of these characteristics between the final submittal and the actual component as delivered and installed.

   a. Where variation in color, pattern, texture, or other characteristic is inherent in the material or product represented, submit at least 3 multiple units that show approximate limits of the variations.

   b. Refer to other Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.

   c. Refer to other Sections for Samples to be returned to the Contractor for incorporation in the Work. Such Samples must be undamaged at time of use. On the transmittal, indicate special requests regarding disposition of Sample submittals.

   d. Samples not incorporated into the Work, or otherwise designated as the Owner's property, are the property of the Contractor and shall be removed from the site prior to Substantial Completion.

3. Preliminary Submittals: Submit a full set of choices where Samples are submitted for selection of color, pattern, texture, or similar characteristics from a range of standard choices.

   a. The Owner will review and return preliminary submittals with the Owner's notation, indicating selection and other action.

4. Submittals: Except for Samples illustrating assembly details, workmanship, fabrication techniques, connections, operation, and similar characteristics, submit 3 sets. The Owner will return one set marked with the action taken.

5. Maintain sets of Samples, as returned, at the Project Site, for quality comparisons throughout the course of construction.

   a. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.

b. Sample sets may be used to obtain final acceptance of the construction associated with each set.

B. Distribution of Samples: Prepare and distribute additional sets to subcontractors, manufacturers, fabricators, suppliers, installers, and others as required for performance of the Work. Show distribution on transmittal forms.

1. Field samples are full-size examples erected on-site to illustrate finishes, coatings, or finish materials and to establish the Project standard.

a. Comply with submittal requirements to the fullest extent possible. Process transmittal forms to provide a record of activity.

1.11 Quality Assurance Submittals

A. Submit quality-control submittals, including design data, certifications, manufacturer's instructions, manufacturer's field reports, and other quality-control submittals as required under other Sections of the Specifications.

B. Certifications: Where other Sections of the Specifications require certification that a product, material, or installation complies with specified requirements, submit a notarized certification from the manufacturer certifying compliance with specified requirements.

1. Signature: Certification shall be signed by an officer of the manufacturer or other individual authorized to sign documents on behalf of the company.

C. Inspection and Test Reports: Requirements for submittal of inspection and test reports from independent testing agencies are specified in Division 1 Section "Quality Control."

1.12 Owner's Action

A. Except for submittals for the record or information, where action and return is required, the Owner will review each submittal, mark to indicate action taken, and return promptly.

1. Compliance with specified characteristics is the Contractor's responsibility.

B. Action Stamp: The Owner will stamp each submittal with a uniform, action stamp. The Owner will mark the stamp appropriately to indicate the action taken, as follows:

1. Final Unrestricted Release: When the Owner marks a submittal "Approved," the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents. Final payment depends on that compliance.

2. Final-But-Restricted Release: When the Owner marks a submittal "Approved as Noted," the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents. Final payment depends on that compliance.

3. Returned for Resubmittal: When the Owner marks a submittal "Not Approved, Revise and Resubmit," do not proceed with Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal according to the notations; resubmit without delay. Repeat if necessary to obtain different action mark.

a. Do not use, or allow others to use, submittals marked “Not Approved, Revise and Resubmit” at the Project Site or elsewhere where Work is in progress.

4. Other Action: Where a submittal is for information or record purposes or special processing or other activity, the Owner will return the submittal marked “Action Not Required.”

C. Unsolicited Submittals: The Owner will return unsolicited submittals to the sender without action.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 01300

SECTION 01421 - DEFINITIONS AND ACRONYMS

PART 1 – GENERAL

1.1 Definitions

A. Definitions Relative to Environmental, Health and Safety:

1. Anchoring: To affix wall anchors, support screws and or fasteners into a building surface. A pilot hole must first be pre-drilled into the building surface before the anchoring device is secured. This activity does not require the use of a “shrouded tool” or personal protective equipment (PPE).

2. Asbestos Abatement: Any activity which has as its principal purpose the removal, enclosure or encapsulation of asbestos or asbestos containing material, including but not limited to, activity in connection with the renovation, repair or demolition.

3. Asbestos Containing Building Materials (ACBM): Any material containing more than one percent asbestos. (Synonymous with ACM).

4. Asbestos Containing Materials (ACM): (per 29 CFR 1926.1101(b)). Any material containing more than one percent asbestos. (Synonymous with ACBM).

5. Asbestos Containing Waste Material: Any waste that contains asbestos. This term includes filters or other materials contaminated with asbestos. This term also includes regulated asbestos containing material waste and materials contaminated with asbestos including disposable equipment and clothing.

6. Asbestos debris: Pieces of ACBM that can be identified by color, texture, or composition, or dust, if the dust is determined by an accredited inspector to be ACBM.

7. Asbestos Management Planner: A state licensed person who uses data gathered by asbestos inspectors to assess asbestos hazards, determine appropriate response actions and develop implementation plans.

8. Asbestos Project Monitor: A state licensed person who:

   a. Collects air and bulk samples and performs visual inspections for the purpose of determining asbestos project completion;

   b. Collects environmental asbestos air samples for the purpose of assessing present or future potential for exposure to airborne asbestos; or

   c. Functions as the on-site representative of the facility owner or other persons by overseeing the activities of the asbestos contractor.

9. Building Surface: ceiling, floor or wall.

10. Certified Industrial Hygienist (C.I.H.): One certified in the practice of industrial hygiene by the American Board of Industrial Hygiene.

11. Competent person: An individual who meets the requirements of the Occupational Safety and Health Administration as a "competent person" for the specific activity involved in the work. The "competent person" must meet the requirements of 29 CFR 1926.32(f) and 29 CFR 1926.1101(b).

12. Coring: To produce a uniform diameter hole in a building surface. (Note: Will be completed by a licensed specialty abatement contractor (i.e., drilling/coring for risers, conduits, etc.)).

13. Drilling: To make a hole in a building surface with the use of a drill. (Note: Will be completed by a licensed specialty abatement contractor (i.e., drilling for risers, conduits, etc.)).

14. Direct Anchoring: To affix wall anchors, support screws and or fasteners to a building surface without the prior drilling of pilot holes. This activity does not require the use of a "shrouded tool" or personal protective equipment (PPE).

15. Friable Asbestos: Any asbestos containing material that when dry, can be crumbled, pulverized or reduced to powder by hand pressure.

16. HEPA Filter: A High Efficiency Particulate Air (HEPA) filter capable of trapping and retaining 99.97% of all mono-dispersed particles of 0.3 microns in diameter.

17. HEPA Filter Vacuum Collection Equipment (or vacuum cleaner): High efficiency particulate air filtered vacuum collection equipment with a HEPA filter.

18. Intact: ACBM that has not crumbled, been pulverized or otherwise deteriorated so that the asbestos is no longer likely to be bound with its matrix.

19. Negative Exposure Assessment: A demonstration which complies with the criteria in paragraph (f)(2)(iii) of the OSHA asbestos standard for construction (29 CFR 1926.1101), that employee exposure during an operation is expected to be consistently below the Permissible Exposure Limits.

20. Negative Pressure Enclosure (NPE): A pressure differential and ventilation system where the work area is maintained at a negative pressure relative to air pressure outside the controlled area.

21. Nonfriable Material: Any material that, when dry, cannot be crumbled, pulverized or reduced to powder by hand pressure and has not been rendered friable.

    a. "Shrouded tool": All tasks involving coring and drilling into building surfaces, whether or not the surfaces contain lead based paint shall use tools equipped with close fitting local exhaust hoods ("shrouded tools") served by a HEPA vacuum cleaner.

    b. Thermal System Insulation (TSI) (per 29 CFR 1926.1101(b)). ACBM applied to pipes, fittings, boilers, breeching, tanks, ducts or other structural components to prevent heat loss or gain.

1.2 Acronyms and Abbreviations

A. Abbreviations and Names: The following acronyms or abbreviations, as referenced in the Contract Documents, are defined to mean the associated names. Names and addresses are subject to change and are believed, but are not assured, to be accurate and up-to-date as of the date of the Contract Documents. This list includes only abbreviations and names relevant to Environmental, Health and Safety matters.

1. ACBM (Asbestos Containing Building Material)

2. ACGIH (American Conference of Governmental Industrial Hygienists)
1330 Kemper Meadow Dr., Suite 600
Cincinnati, OH 45240 (513) 742-2020

3. ACM (Asbestos Containing Material)

4. AIHA (American Industrial Hygiene Association)
2700 Prosperity Ave., Suite 250
Fairfax, VA 22031 (703) 849-8888

5. ANSI (American National Standards Institute)
1819 L Street, NW
Washington, DC 20036 (202) 293-8020

6. ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers)
1791 Tullie Circle, NE
Atlanta, GA 30329 (404) 636-8400

7. CFR (Code of Federal Regulations)
(Available from the Government Printing Office)
Superintendent of Documents
P.O. Box 371954
Pittsburgh, PA 15250-7954 (202) 512-1800
(Material is usually first published in the “Federal Register”)

8. CMR (Code of Massachusetts Regulations)
William Francis Galvin
Secretary of the Commonwealth
State House Bookstore
Boston, MA 02133 (617) 727-2834
Fax: (617) 973-4858
E-mail: regs@sec.state.ma.us

9. DEP Massachusetts (Department of Environmental Protection)
One Winter St.
Boston, MA 02108 (617) 292-5500

10. DPH Massachusetts (Department of Public Health)
250 Washington St.
Boston, MA 02108-4619 (617) 624-6000

11. DLWD Massachusetts (Department of Labor & Workforce Development)
    399 Washington St.
    5th Floor
    Boston, MA 02108 (617) 727-3452

12. EPA (Environmental Protection Agency)
    Region 1
    1 Congress Street
    Boston, MA 02114-2023 (888) 372-7341

13. LBP (Lead Based Paint)

14. OSHA (Occupational Safety and Health Administration)
    (U.S. Department of Labor)
    200 Constitution Ave.
    Washington, DC 20210 (202) 693-1999

15. RFCI (Resilient Floor Covering Institute)
    966 Hungerford Dr., Suite 12-B
    Rockville, MD 20805 (301) 340-8580

16. National Institute of Building Sciences
    1090 Vermont Avenue, NW
    Suite 700
    Washington, DC 20005-4905

END OF SECTION

SECTION 01600 - MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes administrative and procedural requirements governing the Contractor's selection of products for use in the Project.

1. Multiple Prime Contracts: Provisions of this Section apply to the construction activities of each prime contractor.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 1 Section "Reference Standards and Definitions" specifies the applicability of industry standards to products specified.

2. Division 1 Section "Submittals" specifies requirements for submittal of the Contractor's Construction Schedule and the Submittal Schedule.

1.3 Definitions

A. Definitions used in this Article are not intended to change the meaning of other terms used in the Contract Documents, such as "specialties," "systems," "structure," "finishes," "accessories," and similar terms. Such terms are self-explanatory and have well-recognized meanings in the construction industry.

1. "Products" are items purchased for incorporation in the Work, whether purchased for the Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

a. "Named Products" are items identified by the manufacturer's product name, including make or model number or other designation, shown or listed in the manufacturer's published product literature, that is current as of the date of the Contract Documents.

b. "Foreign Products," as distinguished from "domestic products," are items substantially manufactured (50 percent or more of value) outside the United States and its possessions. Products produced or supplied by entities substantially owned (more than 50 percent) by persons who are not citizens of, nor living within, the United States and its possessions are also considered to be foreign products.

2. "Materials" are products substantially shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form a part of the Work.

3. "Equipment" is a product with operational parts, whether motorized or manually operated, that requires service connections, such as wiring or piping.

1.4 Submittals

A. Product List: A list of products required is included at the end of this Section. Prepare a schedule in tabular form showing each product listed. Include the manufacturer's name and proprietary product names for each item listed.

B. Product List: Prepare a list showing products specified in tabular form acceptable to the Owner. Include generic names of products required. Include the manufacturer's name and proprietary product names for each item listed.

1. Coordinate product list with the Contractor's Construction Schedule and the Schedule of Submittals.

2. Form: Prepare product list with information on each item tabulated under the following column headings:

    a. Related Specification Section number.
    b. Generic name used in Contract Documents.
    c. Proprietary name, model number, and similar designations.
    d. Manufacturer's name and address.
    e. Supplier's name and address.
    f. installer's name and address.
    g. Projected delivery date or time span of delivery period.

3. Initial Submittal: Within 30 days after date of commencement of the Work, submit 3 copies of an initial product list. Provide a written explanation for omissions of data and for known variations from Contract requirements.

    a. At the Contractor's option, the initial submittal may be limited to product selections and designations that must be established early in the Contract period.

4. Completed List: Within 60 days after date of commencement of the Work, submit 3 copies of the completed product list. Provide a written explanation for omissions of data and for known variations from Contract requirements.

5. Owner's Action: The Owner will respond in writing to Contractor within 2 weeks of receipt of the completed product list. No response within this period constitutes no objection to listed manufacturers or products but does not constitute a waiver of the requirement that products comply with Contract Documents. The Owner's response will include a list of unacceptable product selections, containing a brief explanation of reasons for this action.

1.5 Quality Assurance

A. Source Limitations: To the fullest extent possible, provide products of the same kind from a single source.

1. When specified products are available only from sources that do not, or cannot, produce a quantity adequate to complete project requirements in a timely manner, consult with the Owner to determine the most important product qualities before proceeding. Qualities may include attributes, such as visual appearance, strength, durability, or compatibility. When a determination has been made, select products from sources producing products that possess these qualities, to the fullest extent possible.

B. Compatibility of Options: When the Contractor is given the option of selecting between 2 or more products for use on the Project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.

1. Each prime contractor is responsible for providing products and construction methods that are compatible with products and construction methods of other prime or separate contractors.

2. If a dispute arises between prime contractors over concurrently selectable, but incompatible products, the Owner will determine which products shall be retained and which are incompatible and must be replaced.

C. Foreign Product Limitations: Except under one or more of the following conditions, provide domestic products, not foreign products, for inclusion in the Work:

1. No available domestic product complies with the Contract Documents.

2. Domestic products that comply with the Contract Documents are available only at prices or terms substantially higher than foreign products that comply with the Contract Documents.

D. Nameplates: Except for required labels and operating data, do not attach or imprint manufacturer's or producer's nameplates or trademarks on exposed surfaces of products that will be exposed to view in occupied spaces or on the exterior.

1. Labels: Locate required product labels and stamps on concealed surfaces or, where required for observation after installation, on accessible surfaces that are not conspicuous.

2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on an easily accessible surface that is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data:

a. Name of product and manufacturer.
b. Model and serial number.
c. Capacity.
d. Speed.
e. Ratings.

1.6 Product Delivery, Storage, and Handling

A. Deliver, store, and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft.

1. Schedule delivery to minimize long-term storage at the site and to prevent overcrowding of construction spaces.

2. Coordinate delivery with installation time to assure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.

3. Deliver products to the site in an undamaged condition in the manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.

4. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.

5. Store products at the site in a manner that will facilitate inspection and measurement of quantity or counting of units.

6. Store heavy materials away from the Project structure in a manner that will not endanger the supporting construction.

7. Store products subject to damage by the elements above ground, under cover in a weathertight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer’s instructions.

PART 2 - PRODUCTS

2.1 Product Selection

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, new at the time of installation.

1. Provide products complete with accessories, trim, finish, safety guards, and other devices and details needed for a complete installation and the intended use and effect.

2. Standard Products: Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.

B. Product Selection Procedures: The Contract Documents and governing regulations govern product selection. Procedures governing product selection include the following:

1. Proprietary Specification Requirements: Where Specifications name only a single product or manufacturer, provide the product indicated. No substitutions will be permitted.

2. Semiproprietary Specification Requirements: Where Specifications name 2 or more products or manufacturers, provide 1 of the products indicated. No substitutions will be permitted.

   a. Where Specifications specify products or manufacturers by name, accompanied by the term “or equal” or “or approved equal,” comply with the Contract Document provisions concerning “substitutions” to obtain approval for use of an unnamed product.

3. Nonproprietary Specifications: When Specifications list products or manufacturers that are available and may be incorporated in the Work, but do not restrict the Contractor to use of these products only, the Contractor may propose any available product that complies with Contract requirements. Comply with Contract Document provisions concerning “substitutions” to obtain approval for use of an unnamed product.

4. Descriptive Specification Requirements: Where Specifications describe a product or assembly, listing exact characteristics required, with or without use of a brand or trade name, provide a product or assembly that provides the characteristics and otherwise complies with Contract requirements.

5. Performance Specification Requirements: Where Specifications require compliance with performance requirements, provide products that comply with these requirements and are recommended by the manufacturer for the application indicated.

   a. Manufacturer's recommendations may be contained in published product literature or by the manufacturer's certification of performance.

6. Compliance with Standards, Codes, and Regulations: Where Specifications only require compliance with an imposed code, standard, or regulation, select a product that complies with the standards, codes, or regulations specified.

7. Visual Matching: Where Specifications require matching an established Sample, the Owner's decision will be final on whether a proposed product matches satisfactorily. a. Where no product available within the specified category matches satisfactorily and complies with other specified requirements, comply with provisions of the Contract Documents concerning "substitutions" for selection of a matching product in another product category.

8. Visual Selection: Where specified product requirements include the phrase "... as selected from manufacturer's standard colors, patterns, textures ..." or a similar phrase, select a product and manufacturer that complies with other specified requirements. The Owner will select the color, pattern, and texture from the product line selected.

9. Allowances: Refer to individual Specification Sections and "Allowance" provisions in Division 1 for allowances that control product selection and for procedures required for processing such selections.

PART 3 - EXECUTION

3.1 Installation of Products

A. Comply with manufacturer's instructions and recommendations for installation of products in the applications indicated. Anchor each product securely in place, accurately located and aligned with other Work.

   1. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

END OF SECTION

SECTION 01701 - CONTROL OF CONTAMINATION

PART 1 – GENERAL

1.1 Related Documents

A. Building system drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this section.

B. Related Sections include the following:

- Section 02081 Work on Surfaces Painted with Lead Based Paint
- Section 02067 Disposal of Waste Materials – Lead Based Paint

1.2 Definitions

A. Controlled Area – A work area where toxic and non-toxic dusts are being produced.

B. General Work Area – A work area where no toxic and/or non-toxic dusts are produced.

C. HEPA Vacuum Cleaner – A vacuum cleaner, wet-dry type, equipped with High Efficiency Particulate Air Filters. Particulate air filtration capable of filtering 0.3 micron particles with 99.97% efficiency.

D. HEPA Filtration – High efficiency particulate air filtration capable of filtering 0.3 micron particles with 99.97% efficiency.

E. MIT has engaged a construction management company to act as its agent and representative for the completion of this project. For the remainder of this document, the construction management company will be referred to as the "Construction Manager".

F. MIT has engaged an environmental consulting firm to act as its representative for environmental assessment activities and related technical services. For the remainder of this document, the consulting firm will be referred to as the "Environmental Consultant".

1.3 Description of Work

A. Certain walls, floors and ceilings on this project may contain lead and in some areas, work will be conducted in close proximity to asbestos containing building materials (ACBM). All penetrations for piping and electrical conduit, etc. will be pre-drilled by a licensed specialty abatement contractor prior to initiation of follow-up construction activities by other trades. This approach will reduce the likelihood of exposure to lead by disturbing lead based painted surfaces. ACBM that would likely be disturbed will be removed prior to construction.

B. Drilling and cutting on non-lead painted surfaces will produce dust that, although non-toxic, can soil floors and furniture and also may damage computers and other electronic equipment to such an extent that extensive cleaning will be necessary. The procedures in this section are designed to minimize the dispersion of dust (both toxic and non-toxic) beyond controlled areas.

PART 2 – PRODUCTS

2.1 HEPA Filter Vacuum Cleaners

A. Use wet-dry tank-type HEPA vacuum cleaners equipped with a filter and metal floor attachment (no brush).

B. Manufacturer: Subject to compliance with requirements, provide products from one of the following companies:

- Nilfisk-Advance America, Inc. — HEPA Vacuum Cleaners
  300 Technology Drive
  Malvern, PA 19355
  (800) 645-3475

- Minuteman International, Inc. — HEPA Vacuum Cleaners
  111 South Rohlwing Road
  Addison, IL 60101
  (630) 627-6900

- Pullman/Holt (White) Corporation — HEPA Vacuum Cleaners
  10702 North 46th Street
  Tampa, FL 33617
  (813) 971-2223
  (800) 237-7582

2.2 Exhaust Ventilated Tools (Shrouded Tools)

A. When determined to be necessary by the Construction Manager in consultation with the Environmental Consultant, power tools (particularly drills) must be equipped with close fitting local exhaust hoods connected to a HEPA vacuum cleaner (shrouded tools). The shrouded tools will be primarily utilized by the licensed specialty abatement contractors. Refer to Section 02081 Work on Surfaces Painted with Lead Based Paint-Part 2 Execution.

2.3 HEPA Filtration (Air Filtration)

A. The utilization of HEPA filtration units is an optional method for the control of dusts generated during work activities.

PART 3 – EXECUTION

3.1 Job Site Security

A. The Contractor, in coordination with the Construction Manager, will secure general work areas from access by public, occupants, staff and/or other users of the building during the project. The Contractor, in coordination with the Construction Manager, will accomplish this where possible, by locking doors, windows or other means of access to the job site.

3.2 Demarcation of Controlled Areas

A. Appropriate signage will be posted at the entrance(s) to controlled areas by the licensed specialty abatement contractor in accordance with applicable Federal, state and local laws and regulations.

3.3 Scheduling

A. Work may be performed only during authorized working hours.

3.4 Contaminated Dust

A. Contaminated dust will be primarily generated during wall and floor coring and drilling activities completed by the licensed specialty abatement contractor. These activities will be completed prior to the initiation of general construction related activities by the Contractor. It is not generally anticipated that other tradesmen will have to implement these procedures during completion of their work. If instances arise that require the initiation of these procedures, the Construction Manager will take appropriate action to address the issue.

B. Penetrations and cuttings (i.e., corings and drilling) into wall and floor surfaces will be done by the licensed specialty abatement contractor using shrouded tools unless otherwise directed.

C. Controlled areas where penetrations are to be made will be isolated from general work areas by utilizing six (6) mil polyethylene sheeting and duct tape.

D. All portable non-work related objects will be removed from the controlled area or covered with six (6) mil polyethylene sheeting and secured with duct tape.

E. All appropriate work surfaces will be covered with six (6) mil polyethylene sheeting and secured with duct tape.

F. Upon completion of wall penetration activity, the polyethylene sheeting will be cleaned using a HEPA vacuum cleaner and wet-wiped prior to the removal of the polyethylene sheeting. Other dusty surfaces in the controlled area will also be cleaned using a HEPA vacuum cleaner and wet-wiped as necessary.

G. Contents of the HEPA vacuum cleaners shall be consolidated into waste containers for the purpose of waste classification. Refer to section 02067 Disposal of Waste Materials – Lead Based Paint-Part 3 Execution.

3.5 Preventing Migration of Contaminants and Non-Toxic Dusts Outside of Controlled Areas and General Work Areas

A. Workers must exercise caution to avoid release of construction dust whether toxic or non-toxic into the air, and to contain dust within the work area particularly if it is known to contain lead or asbestos. All of these procedures must be implemented except those determined to be unnecessary on a case-by-case basis by the Construction Manager considering the circumstances of the work. The Contractor will do the following:

- Shut down any building installed air handling equipment bringing air into or out of the controlled area.
- Place sticky mats at all entrances to the controlled area to remove dust from shoes.
- Provide all workers in the controlled area with disposable work clothes and shoe covers, which must be left in the controlled area when workers exit.
- Do not walk through uncontaminated areas of the building while wearing disposable work clothes or shoe covers.
- Ensure that any portable exhaust fans employed for personal cooling are used so they do not blow dust out windows and other building penetrations.

END OF SECTION

SECTION 01703 - HAZARD COMMUNICATION AND CHEMICAL HANDLING

PART 1 – GENERAL

1.1 Summary

A. This section describes procedures to be used by contractors and the Construction Manager to share hazard communication information between different contractors, and provides general guidelines for the handling of hazardous chemicals that may be encountered during completion of the work required by this contract. This section does not include procedures which are required by OSHA and environmental regulations for chemicals used by contractors for their own work that are the sole responsibility of the contractors.

B. Related Sections include the following:

- Section 01098: Codes, Regulations, Standards and Submittals
- Section 02086: Hazardous Waste Management

1.2 Definitions

A. MIT has engaged a construction management company to act as its agent and representative for the completion of this project. For the remainder of this document, the construction management company will be referred to as the “Construction Manager”.

B. MIT has engaged an environmental consulting firm to act as its representative for environmental assessment activities and related technical services. For the remainder of this document, the environmental consulting firm will be referred to as the “Environmental Consultant”.

1.3 Contractor Responsibilities

A. Contractors and subcontractors are responsible for complying with all environmental, health and safety laws and regulations relating to chemicals used in their own work. Penalties for violations may not be charged back to MIT.

B. Contractors who will be using chemicals for their own work must submit Material Safety Data Sheets (MSDSs) to the Construction Manager prior to use. The Construction Manager may request that certain chemicals be replaced with less hazardous alternatives. The Construction Manager must also submit copies of all MSDSs to the Environmental Consultant.

PART 2 – HAZARD COMMUNICATION

A. The Construction Manager will maintain a file of MSDSs for all chemicals that will be used on the project. A copy of the MSDS file will be maintained on-site at all times. The Environmental Consultant will also maintain a duplicate copy of the MSDS file. Contractors will inform their own employees of the MSDS files and will establish procedures in accordance with the OSHA Hazard Communication Standard (29 CFR 1926.59, 1910.1200) for their employees to review MSDSs.

PART 3 – TOXIC CHEMICALS

3.1 Mercury

A. Mercury metal is found as mercury vapor and in some cases as droplets in fluorescent lamps, as a liquid in some electrical switches and thermostats, and in small batteries for watches, cameras and small electronic toys and appliances. None of these items are hazardous to handle if they are intact. If any of these items are removed from a building or found as trash, they should be disposed of as described in Section 02086 Hazardous Waste Management.

B. If mercury metal (quicksilver) is encountered in any of the following circumstances in close proximity to a working area, the Contractor will notify the Construction Manager who will in turn notify the MIT Industrial Hygiene Office (Telephone No. (617) 253-2596) to remove the mercury from the area before proceeding with the work:

- Glass bottles containing liquid mercury.
- Glass parts of technical equipment containing liquid mercury.
- Droplets or pools of liquid mercury spilled on the floor.

3.2 Polychlorinated Biphenyls (PCBs)

A. Between 1926 and 1977, PCB containing products were manufactured for use in applications where stable, fire-resistant, heat-transfer properties were demanded. The most extensive use of PCBs occurred in dielectric fluids for electrical equipment. During the 1970s, Federal legislation mandated the elimination of PCBs from commerce, but existing equipment containing PCBs could continue in use as long as specific conditions were met. Although MIT has made special efforts to replace all PCB containing equipment, there remains the possibility that certain PCB containing products may still be found on the campus.

B. The following types of equipment may contain PCBs:

- Transformers
- Large, high- and low-voltage capacitors
- Liquid-cooled electric motors
- Hydraulic systems
- Heat-transfer systems
- Fluorescent light ballasts
- Electromagnets
- Liquid-filled cable
- Gasketing and dampening felts
- Switches
- Voltage regulators
- Vacuum pumps
- Microwave ovens
- Electronic equipment

C. When the fluid in a piece of equipment has been analyzed and found to contain less than five (5) ppm of PCBs, the label will contain the phrase “Non-PCB”. If PCBs were not used in the manufacture of an item after 1978, the label will contain the phrase “No PCBs”. Any of the above types of equipment specified in Section 3.2.2. that does not contain one of these labels should be assumed to contain PCBs.

D. If equipment containing (or presumed to contain) PCBs must be removed or if the equipment or the floor around it is oil-stained, the following steps must be completed by the Contractor:

E. The disposal of equipment which contains (or is presumed to contain) PCBs must be completed in accordance with the laws and regulations identified in Section 02086 Hazardous Waste Management.

3.3 Other Hazardous Chemicals

A. If employees of one contractor appear to be exposed to chemicals being used by another contractor, the two parties should discuss the issues to assure that employees of neither company are exposed to hazardous conditions in consultation with the Construction Manager.

B. The Construction Manager may consult the Environmental Consultant and the MIT Industrial Hygiene Office for general guidance on the safe handling of chemicals while on campus.

C. Neither the Environmental Consultant nor the MIT Industrial Hygiene Office will provide personal protective equipment to contractors. Contractors will be solely responsible for the safety and health of their employees and subcontractors during the project in strict conformance with applicable Federal, state and local laws and regulations.

END OF SECTION

SECTION 01704 - MOLDS, FUNGI, ANIMAL, BIRD AND BAT DROPPINGS

PART 1 – GENERAL

1.1 Hazards

A. Attics, basements, crawl spaces, roofs and exterior cornices can be roosting and nesting places for pigeons, starlings, bats and other animals that leave deposits of droppings. The high nutrient content of accumulated bird and bat excrement provides an excellent growth medium for organisms of potential human concern, particularly cryptococcosis and histoplasmosis.

1.2 Definitions

A. MIT has engaged a construction management company to act as its agent and representative for the completion of this project. For the remainder of this document, the construction management company will be referred to as the “Construction Manager”.

B. MIT has engaged an environmental consulting firm to act as its representative for environmental assessment activities and related technical services. For the remainder of this document, the environmental consulting firm will be referred to as the “Environmental Consultant”.

PART 2 – CONTRACTOR RESPONSIBILITIES

2.1 Large Quantities

A. If the Contractor encounters substantial-large deposits of bird or animal droppings (particularly if they are dry), immediate notification must be made to the Construction Manager. It is advisable to engage a specialty contractor to remove the material and install control measures to prevent reinfestation. The Construction Manager will coordinate the hiring of an appropriately qualified and experienced contractor.

2.2 Small Quantities

B. Contractors should consult with the Construction Manager for guidance on the handling of small quantities of bird and animal droppings. The Construction Manager will coordinate with the Environmental Consultant as warranted based on job site conditions confirmed by the Construction Manager.

END OF SECTION

SECTION 01705 - PHYSICAL HAZARDS IN MIT FACILITIES

PART 1 – GENERAL

1.1 Physical Hazards

A. This section discusses physical hazards that may be encountered on this project due to existing systems, installations or activities at the Massachusetts Institute of Technology (MIT), Cambridge, MA. These may include, but are not limited to, the following:

- Lasers
- Microwaves
- Ultraviolet light
- Infrared light
- Electrical and magnetic fields
- Noise
- Heat and cold
- High voltage
- Moving machinery and robots
- Confined spaces

B. Most of the work on this project will not involve exposures to such hazards, but these agents do occur in some of the research laboratories and other facilities at MIT. This section provides guidance on conducting work in MIT facilities where these and other physical hazards occur.

1.2 Definitions

A. MIT has engaged a construction management company to act as its agent and representative for the completion of this project. For the remainder of this document, the construction management company will be referred to as the “Construction Manager”.

B. MIT has engaged an environmental consulting firm to act as its representative for environmental assessment activities and related technical services. For the remainder of this document, the environmental consulting firm will be referred to as the “Environmental Consultant”.

1.3 Area Identification

A. Areas at MIT where the potentially dangerous physical hazards noted above occur are usually marked with signs. Also, the academic department operating the laboratory, the MIT Industrial Hygiene Office or the MIT Safety Office has established rules and procedures to minimize exposures to persons working in the relevant areas.

B. The Construction Manager will coordinate with and advise Contractors of any work to be performed in areas where the above or other relevant physical hazards may be present.

PART 2 – CONTRACTOR RESPONSIBILITIES

2.1 MIT Rules and Procedures

A. Whenever employees of contractors will be working in areas where physical hazard signage is present, the employees must comply with all safety rules and procedures established by the relevant academic department, MIT Industrial Hygiene Office and MIT Safety Office.

B. These rules may require special training and/or personal protective equipment of the Contractor.

C. Contractors may be required to provide documentation to the Construction Manager, which confirms that Contractor's employees have received requisite training and have been provided with appropriate personal protective equipment. Work may not proceed in an area where physical hazard signage is present until the Contractor has provided sufficient documentation and obtained any required written permits from the relevant MIT unit that all MIT rules and procedures are being followed.

D. The Construction Manager is the point-of-contact for coordinating with the relevant MIT unit.

2.2 Temporary Deactivation of Equipment

A. If it appears that it will be necessary to shutdown or otherwise deactivate equipment in a laboratory or other area in order to complete a task of this project, the Contractor must coordinate the deactivation with the Construction Manager.

END OF SECTION

SECTION 01706 - CONSTRUCTION SITE SAFETY ISSUES

PART 1 – GENERAL

1.1 Related Documents

A. Section 01710 Soil and Stormwater Management.

1.2 Summary

A. The completion of certain tasks of this project may require that employees work where they are potentially exposed to hazards created by another contractor. These hazards may include, but are not limited to, working on scaffolds, in or near excavations or exposure to underground utilities. This section describes coordination procedures to be followed so that that workers are not exposed to the risk of injury from these three activities. Other job site hazards may develop during the project which will be the responsibility of the Contractor and its subcontractors to immediately notify the Construction Manager and take appropriate corrective action(s). This section refers to the following Occupational Safety and Health Administration (OSHA) regulations:

- 29 CFR 1926 Subpart L (Scaffolds).
- 29 CFR 1926 Subpart P (Excavations).
- 29 CFR 1910.146 (Permit-Required Confined Spaces).

B. All contractors and subcontractors are solely and directly responsible to ensure that their work is completed in accordance with all applicable environmental and occupational safety and health regulatory requirements (Federal, state and local) during completion of the work required under this project.

C. All contractors and subcontractors shall immediately notify the Construction Manager of any construction related work activity that they believe may pose a risk of injury and/or that requires the institution of new policies and/or work procedures.

1.3 Definitions

A. MIT has engaged a construction management company to act as its agent and representative for the completion of this project. For the remainder of this document, the construction management company will be referred to as the “Construction Manager”.

B. MIT has engaged an environmental consulting firm to act as its representative for environmental assessment activities and related technical services. For the remainder of this document, the environmental consulting firm will be referred to as the “Environmental Consultant”.

1.4 Scaffolds

A. Employees of all contractors on this project are prohibited from working on scaffolds that are unstable or present fall hazards because of missing guardrails or other physical hazards.

B. If a scaffold is missing guardrails or appears to be unstable, the person who has observed the hazard should immediately notify the Construction Manager.

C. The Construction Manager will at a minimum, place a placard on the scaffold warning that it is not to be used until the hazard(s) has been abated.

D. The Construction Manager may also choose to have the scaffold removed from the area until repairs can be completed by the responsible Contractor and/or its subcontractor(s).

1.4 Excavations

A. Employees of all contractors on this project are prohibited from working in or near excavations that do not conform in all respects to the requirements of the OSHA standard on excavations (29 CFR 1926 Subpart P). Refer to Section 01710.

B. If an excavation appears to be dangerous because of nonconformance with the above requirements, or other reason, the Contractor must immediately notify the Construction Manager of the nonconforming condition and take appropriate corrective action(s).

C. The Construction Manager will follow-up the notification in a similar manner as specified in Sections 1.4.2 through 1.4.4.

1.6 Underground Utilities

A. All underground utility vaults are "permit-required confined spaces" that may be entered only by employees of the owners of the vaults. Other workers may enter a utility vault only if they are working under contract with the vault's owner and only if they follow the confined space procedures established by the vault's owner.

END OF SECTION

SECTION 01710 - SOIL AND STORMWATER MANAGEMENT

PART 1 – GENERAL

1.1 Introduction

A. This section is only applicable when ground excavations are necessary as part of the Fire Safety System Renewal Project.

1.2 Definitions

A. MIT has engaged a construction management company to act as its agent and representative for the completion of this project. For the remainder of this document, the construction management company will be referred to as the “Construction Manager”.

B. MIT has engaged an environmental consulting firm to act as its representative for environmental assessment activities and related technical services. For the remainder of this document, the environmental consulting firm will be referred to as the “Environmental Consultant”.

PART 2 - POTENTIAL SUBSURFACE AND OFFSITE CONTAMINATION

2.1 Groundwater

A. If groundwater is observed to be seeping into an excavation or is present within an excavation, immediately stop all excavation activities until Contractor coordinates with the Construction Manager on appropriate measures to maintain job site safety.

B. If any petroleum odors or sheens are observed on the water surface immediately notify the Construction Manager.

C. If no petroleum odors or sheens are noted, backfill the excavation to a depth just above the groundwater table in accordance with appropriate construction practice. Continued lateral excavation is permissible. Continued vertical excavation below the groundwater table may result in an extremely unstable job site condition that may require excavation dewatering to be conducted by the Contractor in coordination with the Construction Manager. Such excavation dewatering activities are the responsibility of the Contractor and/or its subcontractors.

D. If the excavation must proceed deeper below the groundwater table, the Contractor and/or its subcontractors will consult the Construction Manager in order to implement appropriate groundwater collection, storage, and discharge procedures.

2.2 Stormwater

A. Excessive sedimentation from the contact of stormwater with stockpiled soil and/or open soil excavations must be prevented or corrected by the Contractor.

B. All catch basins, to which an excavation and/or soil stockpile would drain, will be surrounded by hay bales and silt fencing. At the request of the Construction Manager, the Environmental Consultant will advise on these products.

C. If excavation activities are to be conducted at or within the one hundred (100) foot buffer to designated wetlands per the Massachusetts Wetlands Protection Act, the Contractor will contact the Construction Manager. Special municipal and state permits are necessary.

2.1 Soil

A. Excavated soil that is known to be free of visual petroleum staining, metals discoloration, asbestos, petroleum odors or any other visual/olfactory signs of contamination may be temporarily stockpiled on-site in designated areas. The Contractor shall coordinate with the Construction Manager to locate the "designated staging area" before any soil stockpiling activities commence.

B. All contaminated soil stockpiles will be placed on six (6) mil polyethylene sheeting and completely covered with six (6) mil polyethylene sheeting by the Contractor. The Contractor will ensure that all contaminated soil stockpiles remain enveloped by six (6) mil polyethylene sheeting until such time as the Contractor arranges for off-site transport and recycling/disposal of the subject soil. The Contractor will contact the Construction Manager for further instruction.

C. The edge of any contaminated or uncontaminated stockpiles must be a minimum of five (5) feet from the final edge of the excavation to help minimize the potential for excavation sidewall collapse.

D. All excavation activity, including competent person inspections and stability precautions, shall comply with OSHA 29 CFR 1926 Subpart P-Excavations.

F. If the excavation depth is expected to exceed five (5) feet below grade, appropriate excavation shoring and/or trench box placement will be installed by the Contractor.

G. Proper atmospheric monitoring and venting techniques for excavations greater than four (4) feet below grade will be employed by the Contractor.

H. No excavation shall be left unsecured overnight or over the weekend.

END OF SECTION

DIVISION 2 - Sitework

Table of Contents

SECTION 02067 - DISPOSAL OF WASTE MATERIALS – LEAD BASED PAINT

PART 1 – GENERAL

1.1 Description of Work

A. This section describes the disposal of lead-containing or lead contaminated waste materials to be generated by the Contractor. Disposal includes packaging of waste materials.

1.2 Definitions

A. MIT has engaged a construction management company to act as its agent and representative for the completion of this project. For the remainder of this document, the construction management company will be referred to as the "Construction Manager".

B. MIT has engaged an environmental consulting firm to act as its representative for environmental assessment activities and related technical services. For the remainder of this document, the environmental consulting firm will be referred to as the "Environmental Consultant".

C. Toxicity Characteristic Leaching Procedure (TCLP): A laboratory test method to determine the mobility of both organic and inorganic analytes present in liquid, solid and multiphasic wastes performed in accordance with test methods required under 40 CFR Part 261.

1.3 Codes and Regulations

A. General Applicability of Codes and Regulations: Except to the extent that more explicit or more stringent requirements are written directly into the Contract Documents, all applicable codes and regulations have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the Contract Documents, or as if published copies are bound herewith.

B. Contractor Responsibility: The Contractor shall assume full responsibility and liability for the compliance with all applicable Federal, state, and local regulations pertaining to hazardous waste management and disposal. The Contractor shall hold MIT, the Construction Manager, the Environmental Consultant, and any third party harmless for failure to comply with any applicable work, hauling, disposal, safety, health or other regulation on the part of the Contractor, the Contractor's employees or its subcontractors.

1.4 Submittals

A. Before Start of Work, the Contractor will submit the following to the Construction Manager for review. Do not start work until these submittals are returned with the Construction "action approval stamp" indicating that the submittal is approved for unrestricted use.

1. Copy of state and/or local license(s) for waste transporter.

2. U.S. EPA identification number for waste transporter.

3. Name and address of waste disposal facility at which hazardous waste are to be disposed. Include contact person, telephone number and EPA identification number. Copy of disposal facility license and permit.

4. Copy of the appropriate state Uniform Hazardous Waste Manifest form.

5. Copy of forms required by state or local agencies.

6. Sample of disposal bag and labels to be used.

B. During the completion of work, the Contractor will submit the following as required by the work.

1. TCLP test results, as required to characterize waste for determination, segregation and packaging purposes.

2. At the completion of hauling and disposal of each waste shipment, the Contractor will submit the appropriate copies of the state uniform hazardous waste manifest to the Construction Manager who will forward the completed manifest documents to the appropriate MIT Office.

PART 2 – PRODUCTS AND EXECUTION

2.1 General

A TCLP waste tests which results in a lead content in the leachate of greater than or equal to five (5) milligrams per liter is to be considered hazardous, handled and disposed of according to local, state, and Federal regulations.

B. Contractor will place all lead based paint waste generated during the project in 6-mil polyethylene disposal bags, then place in a steel drum in the designated storage area.

C. Suspected lead based material may include paint chips, rags, sponges, mops, High Efficiency Particulate Air (HEPA) Vacuum filters and contents, respirator cartridges and other materials used during work activities.

D. Contractor will properly store and secure waste at all times in accordance with all Federal, state and local regulations. Contractor will not leave debris on the grounds outside the work area or in uncovered or unlocked trucks or dumpsters. Contractor will not incinerate debris or use an unauthorized container. Contractor will not introduce lead contaminated water or solid waste into storm or sanitary sewers. Contractor will not permit recycling of building components coated with Lead Based Paint.

E. Any material suspected to contain Lead Based Paint (i.e., contents of HEPA Vacuum Cleaners used while coring into building surfaces painted with Lead Based Paint) must have a TCLP test performed to determine the proper method of disposal for the waste.

2.2 Disposal of Non-Hazardous Solid Waste (As Determined By TCLP Testing)

A. Materials that were suspected to contain Lead Based Paint and that passed TCLP testing and are not hazardous or special waste for any other reason, can be disposed of as solid waste (normal trash).

2.3 Disposal of Hazardous Solid Wastes (As Determined By Testing)

A. MIT is classified as a Large Quantity Generator (LQG) of hazardous waste (U.S. EPA generator number MAD001425594). The MIT Environmental Management Office must be contacted by the Construction Manager prior to the removal of any waste materials. Contact: Brian Foti (617) 258-8023 or Bill Van Schalkwyk (617) 253-9492.

B. TCLP testing for Contractor's use in fulfilling waste management requirements is at the Contractor's expense.

C. TCLP test analysis will be performed in accordance with methods required under 40 CFR Part 261.

D. Contractor will comply with all Federal, state and local regulations

E. Contractor will provide six (6) mil thick leak-tight polyethylene bags then place material in the appropriate DOT approved steel drum and label drum in accordance with all applicable Federal, state and local regulations.

F. All waste is to be hauled by a licensed waste hauler with all required licenses from all Federal, state and local authorities with jurisdiction.

G. Contractor will load all waste material into properly labeled disposal bags, leak-tight steel drums. All materials are to be contained in the following:

- Package in the appropriate DOT approved container.
- One 6-mil polyethylene disposal bag
- Fill to capacity,
- Install gasket on lid, apply locking and seal, and
- Apply and complete a hazardous waste label to drum site.

H. Contractor will carefully load containerized waste in drum. Exercise care before and during transport, to ensure that no unauthorized persons have access to the material.

I. Contractor will not store containerized materials outside of the work area unless the containers are temporarily staged until full in the designated storage areas with the prior approval of the Construction Manager.

J. Contractor will maintain containerized materials in accordance with all applicable Federal, state and local regulations.

K. Contractor will continuously maintain custody of all hazardous waste generated at the job site including security, short-term storage, transportation and disposition until custody is transferred to an approved transporter, disposal site or recycling center.

L. Contractor will not remove, or cause to be removed, hazardous waste from MIT's property without a legally executed state appropriate uniform hazardous waste manifest.

M. Removal of Hazardous Waste: Contractor will arrange for the movement of full containers of hazardous waste from the work site within seventy-two (72) hours of being filled to the main accumulation area. The Construction Manager will identify hazardous waste storage locations, for in use containers, on the site for the Contractor's use and the location of the main accumulation area for full containers.

N. At completion of hauling and disposal of each load, Contractor will submit the appropriate copies of the uniform hazardous waste manifest and disposal receipt to the Construction Manager who will forward to the appropriate MIT office.

2.4 Backcharges

A. Where Contractor fails to fulfill packaging, handling, or disposal requirements as outlined herein, MIT will charge back to Contractor all costs associated with insuring that hazardous wastes are packaged and segregated in accordance with all applicable Federal, state and local regulations.

B. Environmental pollution of MIT property resulting from Contractor's hazardous waste management activities shall be promptly remediated under the Construction Manager's direction, to MIT's sole satisfaction, and at the Contractor's sole expense.

C. Contractor agrees to either reimburse MIT, or reduce the Contract amount by change order to cover all costs associated with waste repackaging, waste re-segregation, pollution remediation efforts and/or any other curative measures.

END OF SECTION

SECTION 02070 - DEMOLITION

1. **General Building Demolition:** General building demolition may require asbestos or other hazardous waste removal. Review asbestos and hazardous waste issues with M.I.T. Safety Office and Environmental Medical Service.

   A. The Massachusetts State Building Code, Section 1212.7 requires existing standpipes to be operational during demolition. M.I.T. also requires existing standpipes to remain operational during construction. Coordination is also required with the City of Cambridge Fire Department.

2. **Selective Demolition:** Selective demolition may also require asbestos or other hazardous waste removal. Review asbestos and hazardous waste issues with M.I.T. Safety Office and Environmental Medical Service. Selective demolition by definition is controlled demolition. Contract Documents for selective demolition must be very clear about what is to be removed and what is to remain. To the greatest extent possible, concealed conditions should be reviewed and anticipated by using existing building drawings and record drawings. Selective demolition with incomplete, unclear, or inaccurate documents can result in Change Orders.

   A. Prior to selective demolition, especially in occupied buildings, contact the M.I.T. Safety Office and coordinate the requirements for fire protection, sprinklers, fire alarm systems, exits and means of egress, emergency lighting, cutting and welding operations and permits, and other conditions. Incorporate the Safety Office's recommendations into the Contract Documents.

3. **Salvage:** In either general building demolition or selective demolition, certain existing items such as locksets, equipment, and other items may need to be salvaged for re-use or maintenance stockpile for other buildings. Review the existing buildings and spaces to be demolished carefully and itemize items to be salvaged.

   A. All lock cylinders required to be removed must be returned to M.I.T.

   B. All existing elevator hands-free phones, when replaced or removed, must be returned to M.I.T. Electrical Services.

4. **Clarification of Scope:** Selective demolition related work often results in Change Orders because the scope of demolition is sometimes defined in several different portions of the Contract Documents [mechanical demolition on mechanical drawings, structural demolition on structural drawings, and so on]. The Designer should coordinate all demolition information in the Contract Documents to ensure that all demolition is clearly indicated and to minimize "buy it twice" problems by having more than one subcontractor assume it is responsible for specific demolition items.

5. **Required Submittals:** Demolition plans, schedules, and phasing sequences created by the Contractor should be submitted for review prior to beginning demolition work. This is especially important for selective demolition in an occupied building. Demolition work must be coordinated with the building occupancy to minimize disruption of the occupant's normal business. Coordinate requirements for temporary dust partitions and general dust control with Environmental Medical Service and OSHA requirements.

END OF SECTION

SECTION 02081 - WORK ON SURFACES PAINTED WITH LEAD BASED PAINT

PART 1 - GENERAL

1.1 Related Documents

A. Section 01701 Control of Contamination.

1.2 Definitions

A. MIT has engaged a construction management company to act as its agent and representative for the completion of this project. For the remainder of this document, the construction management company will be referred to as the "Construction Manager".

B. MIT has engaged an environmental consulting firm to act as its representative for environmental assessment activities and related technical services. For the remainder of this document, the environmental consulting firm will be referred to as the "Environmental Consultant".

C. HEPA Vacuum Cleaner – A vacuum cleaner, wet-dry type, equipped with High Efficiency Particulate Air (HEPA) Filter. Particulate air filtration capable of filtering 0.3 micron particles with 99.97% efficiency.

D. HEPA Filtration – High efficiency particulate air filtration capable of filtering 0.3 micron particles with 99.97% efficiency.

1.3 Description of Work

A. This section describes procedures to be followed when certain types of work will be performed that will break up and/or disturb lead based paint. The tasks covered in this section are primarily:

- Penetrating walls, ceilings and floors for insertion of pipes and electrical conduits;
- Removing components such as stairwell railings and electrical fixtures;
- Attaching components such as surface mounted electrical fixtures, junction boxes and supports for sprinkler pipes.

B. These procedures do not cover operations where more than a few square inches of well adhered paint in good condition is disturbed. Where larger areas of paint will be removed and/or the paint is peeling, more stringent procedures must be used after consultation with the Construction Manager and the Environmental Consultant.

PART 2 – PRODUCTS AND EXECUTION

2.1 Penetrating Surfaces Coated with Lead Based Paint

A. This procedure is to be followed for drilling holes in walls, floors and ceilings through which pipes and electrical conduits will be passed.

B. To the greatest extent possible, holes will be predrilled by a licensed specialty abatement contractor before pipes or conduits are installed.

C. Coring tools and other power tools (particularly drills) equipment must be equipped with close fitting local exhaust hoods "shrouded tools" served by HEPA suction equipment. If the use of such hoods is infeasible because of the location or nature of the work, a portable local exhaust hood (i.e., HEPA vacuum hose) must be positioned as close as possible to the point of penetration. "Shrouded tools" will be utilized by specialty abatement contractors. These activities will be completed prior to the initiation of general construction related activities.

D. All portable objects within the work area shall be removed or covered with six (6) mil polyethylene sheeting secured with duct tape. All surfaces with the potential to be contaminated by the dust generated from the drilling activity will be covered with six (6) mil polyethylene sheeting and secured with duct tape. Refer to Section 01701 Control of Contamination.

E. Wherever possible, doors to other parts of the building will be kept closed to prevent migration of dust. Six (6) mil polyethylene sheeting will also be utilized to isolate work areas. Refer to Section 01701 Control of Contamination-3.4 Contaminated Dust.

F. On completion of the work in a given room or work area, the floor near the penetration(s) must be vacuumed with a HEPA vacuum cleaner and wet wiped. Other surfaces such as windowsills and furniture that have become dusty must also be vacuumed. Refer to Section 01701 Control of Contamination-3.4 Contaminated Dust.

2.2 Removing Components from Surfaces Painted with Lead Based Paint

A. This procedure is to be followed for removing objects, such as light fixtures, stair rails and brackets, from surfaces coated with lead based paint.

B. This procedure does not cover tasks that require that the mounting surface be damaged substantially. It also does not cover the removal of structural components such as door and window frames or built-in furniture such as cabinets. Consult with the Construction Manager and the Environmental Consultant before performing these tasks.

C. No special tools or techniques are required for this procedure.

D. Wherever possible, doors to other parts of the building will be kept closed to prevent the migration of dust.

E. On completion of the work in a given room or work area, the floor near the work must be vacuumed with a HEPA vacuum cleaner and wet wiped. Other surfaces such as windowsills and furniture that have become dusty must also be vacuumed. Refer to Section 01701 Control of Contamination-3.4 Contaminated Dust.

2.3 Anchoring or Direct Anchoring Components to Surfaces Painted with Lead Based Paint

A. This Anchoring or Direct Anchoring procedure is to be followed for fastening small components such as surface mounted electrical fixtures, junction boxes, sprinkler pipe hangers and electrical conduits to walls and ceilings that have been painted with lead based paint. Refer to Section 01421 Definitions and Acronyms – Part 1 General.

B. No special tools or techniques (i.e., "shrouded tools" or personal protective equipment) are required for this procedure.

C. Wherever possible, doors to other portions of the building will be kept closed to prevent the migration of dust.

D. On completion of the work in a given room or work area, the floor near the work must be vacuumed with a HEPA vacuum cleaner and wet wiped. Other surfaces such as windowsills and furniture that have become dusty must also be vacuumed. Refer to Section 01701 Control of Contamination-3.4 Contaminated Dust.

END OF SECTION

SECTION 02083 - DISCOVERY OF SUSPECT ASBESTOS CONTAINING BUILDING MATERIALS DURING CONSTRUCTION

PART 1 – GENERAL

1.1 Related Documents

A. Building system drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.

1.2 Description of the Work

A. Prior to commencement of the work of this project, Asbestos Containing Building Materials (ACBM), that could include ceiling tiles, resilient vinyl floor covering in areas where penetrations will be necessary and asbestos insulation in close proximity to other work on this project, will be removed by a licensed asbestos abatement contractor. This section describes the procedure to be used when suspect ACBM are discovered during the completion of the construction work of this project by various tradesmen.

1.3 Definitions

A. MIT has engaged a construction management company to act as its agent and representative for the completion of this project. For the remainder of this document, the construction management company will be referred to as the “Construction Manager”.

B. MIT has engaged an environmental consulting firm to act as its representative for environmental assessment activities and related technical services. For the remainder of this document, the environmental consulting firm will be referred to as the “Environmental Consultant”.

PART 2 – EXECUTION

2.1 Potential Discovery

A. If a workman of any trade discovers material, which appears to be ACBM, he/she shall stop work and notify his/her supervisor, who in turn will notify the Construction Manager.

Materials of concern include, but are not limited to:

- Ceiling tiles
- Vinyl floor tile
- Linoleum
- Insulation on pipes, hot water heaters and furnaces
- Insulation on electrical cables, and
- Transite board.

2.2 Response Action

A. The Construction Manager will request that the Environmental Consultant sample the suspect ACBM, submit the sample(s) for analysis to an accredited analytical laboratory and request a turnaround of 24 hours or less. Based on the outcome of the analysis, the Construction Manager will authorize the continuation of the task without any special precautions if the material in question did not contain asbestos, or the Construction Manager will engage a licensed asbestos abatement contractor to properly remove the ACBM in accordance with applicable Federal, State and local regulations.

2.3 Continuation of Work

A. The work that was interrupted may continue only after explicit authorization by the Construction Manager.

END OF SECTION

SECTION 02084 - DISPOSAL OF REGULATED ASBESTOS CONTAINING BUILDING MATERIAL

PART 1 – GENERAL

1.1 Description of Work

A. This section describes the disposal of Asbestos Containing Building Materials (ACBM). Disposal includes packaging of ACBM. Disposal shall be accomplished by land filling.

1.2 Definitions

A. MIT has engaged a construction management company to act as its agent and representative for the completion of this project. For the remainder of this document, the construction management company will be referred to as the "Construction Manager".

B. MIT has engaged an environmental consulting firm to act as its representative for environmental assessment activities and related technical services. For the remainder of this document, the environmental consulting firm will be referred to as the "Environmental Consultant".

1.3 Codes and Regulations

A. General Applicability of Codes and Regulations: Except to the extent that more explicit or more stringent requirements are written directly into the Contract Documents, all applicable codes and regulations have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the Contract Documents, or as if published copies are bound herewith.

B. Contractor Responsibility: The Contractor shall assume full responsibility and liability for the compliance with all applicable Federal, state, and local regulations pertaining to hazardous waste management and disposal. The Contractor shall hold MIT, the Construction Manager, the Environmental Consultant, and any third party harmless for failure to comply with any applicable work, hauling, disposal, safety, health or other regulation on the part of the Contractor, the Contractor's employees or its subcontractors.

1.4 Submittals

A. Before the Start of Work. The Contractor will submit the following to the Construction Manager for review. Do not start work until these submittals are returned with Construction Manager's "action-approval stamp" indicating that the submittal is approved for unrestricted use.

1. Copy of state and/or local licenses for waste hauler.
2. Name and address of landfill where ACBM are to be disposed. Include contact person and telephone number. Copy of disposal facility license and permit.
3. Copy of waste shipment record.
4. Sample of disposal bag and any added labels to be used.

B. The Contractor will submit to the Construction Manager copies of all waste shipment records and disposal site data, which describe the nature, size, type of container, and form of asbestos waste managed.

C. Waste Shipment Record. The Contractor will maintain a waste shipment record as required by Federal, state and local regulation which indicates the waste generator, transporter, and disposal site, and which describes the nature, size, type of container, and form of asbestos waste disposed. The Contractor will submit to the Construction Manager who will forward the executed waste shipment record to the appropriate MIT office.

PART 2 – PRODUCTS AND EXECUTION

2.1 General

A. Disposal Bags. The Contractor will provide 6 mil (0.15 mm) thick leak-tight polyethylene bags labeled in accordance with all applicable Federal, state and local regulations.

B. Labeled, leak tight rigid containers may be used upon the approval of the Construction Manager.

C. Contractor will comply with all applicable Federal, state and local regulations and standards.

D. All waste is to be hauled by a waste hauler with all required licenses from all Federal, state and local authorities with jurisdiction.

E. Contractor will load all adequately wetted ACBM in disposal bags or leak-tight containers. All materials are to be contained in one of the following:

- Two 6 mil (0.15 mm) disposal bags, or
- Two 6 mil (0.15 mm) disposal bags and an appropriate DOT approved fiberboard drum.

F. Contractor will carefully load containerized waste in fully enclosed dumpsters, trucks or other appropriate vehicles for transport. The Contractor will exercise care before and during transport, to ensure that no unauthorized persons have access to the material.

G. Warning Signs. Contractor will mark during loading, staging and unloading all dumpsters, receptacles and vehicles in which ACBM is being or has been placed with a sign complying with requirements of all Federal, state and local regulations.

H. Contractor will not store containerized materials outside of the Work Area. Contractor will properly store and secure waste at all time in accordance with all Federal, state and local regulations. Contractor will take containers from the Work Area directly to a sealed truck or dumpster. Contractor will coordinate directly with the Construction Manager regarding the location of the sealed truck and/or dumpster.

I. Contractor will continuously maintain custody of all ACBM generated at the job site including security, short-term storage, transportation and disposition until custody is transferred to an approved transporter or disposal site.

J. Contractor will not transport or dispose of bagged ACBM materials in open trucks. Contractor will label drums with same warning labels as bags. Uncontaminated drums may be reused. Contractor will treat drums that have been contaminated as ACBM and dispose of them in accordance with this specification.

K. Contractor will advise the landfill operator or processor, at least ten (10) days in advance of transport, of the quantity of material to be delivered.

L. Contractor will not remove, or cause to be removed, ACBM from MIT's property without a legally executed waste shipment record.

M. Contractor will retain receipts from landfill or processor for all ACBM materials that have been disposed off-site.

N. At completion of hauling and disposal of each load, Contractor will submit a copy of the waste shipping record and landfill receipt to Construction Manager who will forward the executed documents to the appropriate MIT office.

2.2 Backcharges

A. Where Contractor fails to fulfill packaging, handling, or disposal requirements as outlined herein, MIT will charge back to Contractor all costs associated with insuring that ACBM waste are packaged and segregated in accordance with all applicable Federal, state and local regulations.

B. Environmental pollution of MIT property resulting from Contractor's ACBM waste management activities shall be promptly remediated under the Construction Manager's direction, to MIT's sole satisfaction, and at the Contractor's sole expense.

C. Contractor agrees to either reimburse MIT, or reduce the Contract amount by change order to cover all costs associated with waste repackaging, waste re-segregation, pollution remediation efforts and/or any other curative measures.

END OF SECTION

SECTION 02086 - HAZARDOUS WASTE MANAGEMENT

PART 1 – GENERAL

1.1 Description of Work

A. This Section describes the disposal of hazardous waste materials (i.e., Polychlorinated biphenyl (PCB) containing fluorescent light ballasts and mercury containing switches from thermostats are waste material frequently encountered with building renovations) that may be generated by the Contractor. Disposal includes packaging of waste materials.

B. For procedures for the disposal of asbestos and lead containing wastes refer to:

- Section 02084 Disposal of Regulated Asbestos Containing Building Material.
- Section 02067 Disposal of Waste Materials – Lead Based Paint.

C. This section describes the segregation, packaging, labeling, transport, and disposal of waste materials generated by renovation activities and the subsequent shipment of properly packaged and labeled waste materials to an approved disposal site.

D. The materials covered by this section include, but are not limited to the following:

- PCB-containing ballasts from fluorescent light fixtures;
- Mercury-containing waste.
- Thermostats with mercury switches.
- Fluorescent and mercury-vapor lamps.

E. If other types of waste are encountered during the project, the Construction Manager should be consulted to determine the appropriate methods of handling and disposal. In addition, the MIT Environmental Management Office must be contacted by the Construction Manager prior to the removal of any waste materials. Contact: Brian Foti (617) 258-8023 or Bill Van Schalkwyk (617) 253-9492.

1.2 Definitions

A. Toxicity Characteristic Leaching Procedure (TCLP): A laboratory test method to determine the mobility of both organic and inorganic analytes present in liquid, solid, and multiphasic wastes performed in accordance with test methods required under 40 CFR Part 261.

B. Mercury-containing lamp: Means any bulb or tube portion of an electric lighting device specifically designed to produce radiant energy, including, but not limited to incandescent, fluorescent, high intensity discharge, and neon lamps in which mercury is purposely introduced by the manufacturer for the operation of the lamp.

C. Mercury-containing device: Any electrical product or component (excluding batteries, lamps and thermostats), which contains elemental mercury that is necessary for its operation and is housed within an outer metal, glass or plastic casing. Mercury-containing devices include, but are not limited to, thermocouples, thermometers, manometers. barometers, sphygmomanometers, electrical switches and relays, as well as certain gas flow regulators and water meters.

D. Universal waste: Any of the following hazardous wastes, as further described in 310 CMR 30.1020, that are managed under the universal waste requirements of 310 CMR 30.1000:
- Batteries;
- Pesticides;
- Thermostats;
- Mercury-containing devices; and
- Mercury-containing lamps.

[Note: Not all batteries, pesticides and lamps are hazardous wastes, and therefore, they do not all qualify as universal wastes; such wastes may instead be managed as non-hazardous solid wastes.]

E. MIT has engaged a construction management company to act as its agent and representative for the completion of this project. For the remainder of this document, the construction management company will be referred to as the "Construction Manager".

F. MIT has engaged an environmental consulting firm to act as its representative for environmental assessment activities and related technical services. For the remainder of this document the consulting firm will be referred to as the "Environmental Consultant".

1.3 Codes and Regulations

A. General Applicability of Codes and Regulations: Except to the extent that more explicit or more stringent requirements are written directly into the Contract Documents, all applicable codes and regulations have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the Contract Documents, or as if published copies are bound herewith.

B. Contractor Responsibility: The Contractor shall assume full responsibility and liability for the compliance with all applicable Federal, state, and local regulations pertaining to hazardous waste management and disposal. The Contractor shall hold MIT, the Construction Manager, the Environmental Consultant, and any third party harmless for failure to comply with any applicable work, hauling, disposal, safety, health or other regulation on the part of the Contractor, the Contractor's employees or its subcontractors.

1.4 Submittals

A. Before Start of Work, the Contractor will submit the following to the Construction Manager for review. Do not start work until these submittals are returned with the Construction Manager "action approval stamp" indicating that the submittal is approved for unrestricted use.

1. Copy of state and local license(s) for waste transporter.
2. U.S. EPA identification number for waste transporter.
3. Name and address of waste disposal facility at which hazardous wastes are to be disposed. Include contact person, telephone number and EPA identification number. Copy of disposal facility license and permit.
4. Copy of the appropriate state Uniform Hazardous Waste Manifest form.
5. Copy of forms required by state or local agencies.

6. Sample of disposal bag and labels to be used

B. During Work: Contractor will submit the following as required by the work.

1. TCLP test results, as required to characterize waste for determination, segregation and packaging purposes.

2. At the completion of hauling and disposal of each waste shipment, the Contractor will submit the appropriate copies of the state uniform hazardous waste manifest to the Construction Manager who will forward to the appropriate MIT office.

PART 2 – PRODUCTS AND EXECUTION

2.1 General

A. TCLP waste tests which results in a lead content in the leachate of greater than or equal to five (5) milligrams per liter is to be considered hazardous, handled and disposed of according to local, city, state, and federal regulations.

B. Place all hazardous waste in containers appropriate for the waste. Comply with all Federal, state and local regulations for waste disposal.

C. Contractor will properly store and secure wastes at all times in accordance with all Federal, state and local regulations.

D. Contractor will not mix potentially hazardous waste streams. Where feasible, separate each type of hazardous waste from other types from hazardous wastes, from asbestos waste, and from non-hazardous construction waste.

E. Contractor will segregate, package, label, transport and dispose of Hazardous Waste in accordance with all Federal, state and local regulations.

2.2 Disposal of Non-Hazardous Solid Waste (As Determined by TCLP Testing)

A. Material that were suspected to contain a characteristic hazardous waste constituent and that passed TCLP testing and is not a hazardous or special waste for any other reason can be disposed of as solid waste (normal trash).

B. Non-hazardous waste

1. Contractor will transport and legally dispose of non-hazardous waste products, materials, residues and refuse at a location not on MIT's property.

Non-hazardous waste products, materials, residues and refuse include, but are not necessarily limited to:

- Wood
- Paper
- Glass
- Empty cardboard containers

- Materials which are determined to be non-hazardous wastes through objective sampling in accordance with TCLP testing and are not a hazardous or special waste for any other reason
- A container which has been emptied of its hazardous contents by pouring or scraping so that less than one inch of material remains in the bottom of the container, the container is considered "empty" and is not in itself a hazardous waste.
- Personal protective clothing and safety equipment with de minimis or trace contamination, as determined by visual inspection by the Construction Manager.

2. Contractor will place non-hazardous construction debris wastes on a daily basis in secure containers for local landfill disposal.

2.3 Disposal of Hazardous Solid Waste (As Determined by TCLP Testing)

A. MIT is classified as a Large Quantity Generator (LQG) of hazardous waste (U.S. EPA generator number MAD001425594). The MIT Environmental Management Office must be contacted by the Construction Manager prior to the removal of any waste materials. Contact: Brian Foti (617)258-8023 or Bill Van Schalkwyk (617) 253-9492.

B. TCLP testing for Contractor's use in fulfilling waste management requirements is at the Contractor's expense.

C. TCLP test analysis will be performed in accordance with methods required under 40 CFR Part 261.

D. All waste is to be hauled by a licensed waste hauler with all required licenses from all state and local authorities with jurisdiction.

E. The following waste products are designated by MIT as non-salvageable and as Hazardous Waste Types:

1. Waste Type A: PCB waste.

- PCB-containing ballasts from fluorescent light fixtures.

2. Waste Type B: Mercury-containing waste.

- Thermostats with mercury switches.
- Fluorescent and mercury-vapor lamps.

3. Waste Type C: Lead based paint waste.

- Refer to Section 02067 - Disposal of Waste Materials - Lead-Based Paint

F. Hazardous Waste Packaging and Labeling: The Contractor will package each segregated Hazardous Waste Type A, B, and C in specified containers as follows. IMPORTANT: Do Not Mix Waste Stream Types.

1. Waste Type A

- Package in the appropriate DOT approved containers with a single polyethylene liner.
- Fill to capacity only with Waste Type A (Do Not Mix Waste Stream Types).
- Install gasket on lid, apply lock ring, and seal.
- Apply and complete a Hazardous Waste Label to drum side.

2. Waste Type B

- Package in the appropriate DOT approved container for mercury waste. Fluorescent and other bulbs may be packaged in their original shipping containers.
- Fill liner bags only with Waste Type B (Do Not Mix Waste Stream Types). Do not mix lamps with other mercury devices. Separate thermostats from other mercury-containing devices.
- Apply Label to container as soon as waste is accumulated.
- Label waste container in accordance with all Federal, state and local regulations.
- Keep containers closed and sealed except when adding or removing waste.
- Securely seal all containers when full.

3. Waste Type C

- Refer to Section 02067 - Disposal of Waste Materials - Lead-Based Paint

4. Temporary Storage: Partially filled containers of hazardous waste may be stored at the job site provided that these storage areas comply with all applicable Federal, state and local regulations for waste storage.

   The Construction Manager will identify temporary storage location for use by the Contractor.

5. Removal of Hazardous Wastes: The Contractor will arrange for movement of full containers of hazardous waste from the job site within seventy-two (72) hours of being filled to the main accumulation area. The Construction Manager will identify hazardous waste storage locations, for in-use containers on the site, for the Contractors use and the location of the main accumulation area for full containers.

6. Contractor will continuously maintain custody of all hazardous waste generated at the job site including security, short-term storage, transportation and disposition until custody is transferred to an approved transporter, disposal site or recycling center.

7. Contractor will not remove, or cause to be removed, hazardous waste from MIT's property without a legally executed state appropriate uniform hazardous waste manifest, or a bill of lading for Universal Waste as defined and regulated by the Commonwealth of Massachusetts.

8. At completion of hauling and disposal of each load, Contractor will submit the appropriate copies of the uniform hazardous waste manifest and disposal receipt to the Construction Manager who will forward to the appropriate MIT office.

9. Recycling and Recovery: Contractor will turn over waste which contains materials for which recovery and/or recycling is possible to an MIT approved recycling center. The Construction Manager will contact the Environmental Management Office for guidance. Refer to Section 2.3.1 of this document. Materials subject to recycling include:

- Fluorescent light lamps
- Thermostats with mercury switches
- Universal Waste Batteries

Upon completion of recycling and/or recovery activities, the Contractor will provide a certificate of recycling or recovery from the waste receiving facility for the benefit of MIT.

2.4 Backcharges

A. Where the Contractor fails to fulfill packaging, handling, or disposal requirements as outlined herein, MIT will charge back to Contractor all costs associated with insuring that hazardous wastes are packaged and segregated in accordance with all Federal, state and local regulations.

B. Environmental Pollution of MIT's property resulting from the Contractor's hazardous waste management activities shall be promptly remediated under the Construction Manager's direction, to MIT's sole satisfaction, and at the Contractor's sole expense.

C. The Contractor agrees to either reimburse MIT, or reduce the Contract amount by change order to cover all costs associated with waste packaging, waste re-segregation, pollution remediation efforts and/or any other curative measures.

END OF SECTION

SECTION 02100 - SITE PREPARATION

PART 1 - GENERAL

1.1 References

A. The General Documents, as listed on the Table of Contents, and applicable parts of General Conditions, shall be included in and made a part of this Section.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this trade.

C. Reference to Mass. DPW Specifications (Mass. SSHB) shall mean the Commonwealth of Massachusetts Department of Public Works "Standard Specifications for Highways and Bridges," 1988 edition.

1.2 Scope of Work

A. Provide all labor, materials and supervision necessary to complete the work specified in this Section as shown on the Contract Drawings.

B. Special attention is directed to requirements covering existing site conditions to be protected and preserved in the finished work, and to the Initial Sequence of Construction Activities and Preliminary Drainage Control specified herein.

C. The work shall include, but shall not be limited to the following:

1. Installation of new 12" fire main with connection to existing fire main.

2. Installation of new gate valves, tees, fittings, hydrants, and other appurtenant work.

1.3 Related Work Specified Elsewhere

A. The following items of related work are specified and included under other Sections of the Specifications:

1. Section 02200, EARTHWORK.
2. Section 02513, PAVING AND PATCHING.
3. Section 02665, WATER PIPING AND APPURTENANCES.
4. Section 03300, FIELD CONCRETE.

1.4 Permits and Codes

A. All work shall comply with all codes, rules, regulations, laws and ordinances of the City of Cambridge, of the Commonwealth of Massachusetts, and all other authorities having jurisdiction. All work necessary to make site preparation comply with such requirements shall be provided without additional cost to the Owner.

B. The Contractor shall procure and pay for all permits and licenses required for work under this Section.

C. The Contractor shall not close or obstruct any streets, sidewalks, or passageways, unless and until they have been discontinued by the City of Cambridge unless and until he shall have first secured all necessary municipal or other permits thereof. No material whatsoever shall be placed or stored in streets or passageways until they have been so discontinued. The Contractor shall conduct his operations to interfere as little as possible with the use ordinarily made of roads, driveways, sidewalks, or other facilities near enough to the work to be affected thereby.

1.5 Examination of Site and Documents

A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of lack of full knowledge of existing conditions.

B. Plans, surveys, measurements and dimensions, under which the work is to be performed are believed to be correct to the best of the Owner's knowledge, but the Contractor shall have examined them for himself during the bidding period, as no allowance will be made for any errors or inaccuracies that may be found herein.

1.6 Staging Area

A. No parking is permitted within the right-of-way of adjacent streets. The Contractor shall submit plan for parking of construction workers prior to commencing construction.

1.7 Disposition of Existing Utilities

A. Active utilities existing on the site shall be carefully protected from damage and relocated or removed or abandoned as required by the work. When an active utility line is exposed during construction, its location and elevation shall be plotted on the record drawings as described in this Section and the utility owner notified in writing.

B. Inactive or abandoned utilities encountered during construction operations shall be removed, plugged or capped. The location of such utilities shall be noted on the record drawings and reported in writing to the Owner.

PART 2 - PRODUCTS

2.1 Materials.

A. See other parts of specification.

PART 3 - EXECUTION

3.1 Workmanship

A. Before beginning demolition work, disconnect or arrange for the disconnection of all utility service lines to items being demolished. Notify the proper local authorities and utility companies, in writing, before work commences. Remove all utility and service lines in accordance with the authorities and/or companies having jurisdiction over such work. Identify the location of all caps and plugs to the Owner in writing.

B. Take all possible precautions to avoid damaging those materials which are to be salvaged or reused on the site.

C. Demolition work shall be carried out in a careful and orderly manner. Provide adequate protection to persons and property inside and outside of the site.

3.2 Title, Salvage and Reuse

A. Property belonging to public bodies or public service companies shall not become the property of the Contractor unless written authorization is given by the Owner.

B. All other salvage and materials resulting from the demolition shall become the property of the Contractor unless otherwise directed by the Owner and shall be removed from the site.

3.3 Disposal

A. Demolish and remove pavement and other items as shown on the Drawings to a depth of two feet below finish grade.

B. Remove completely all existing pavements that fall in the location of new utilities, paved areas, lawn areas or in other areas that will be affected by new construction. Edges shall be saw cut.

C. Remove and legally dispose of off-site, at no cost to the Owner, all soil, all materials and debris resulting from the demolition work, other than those to be salvaged, stockpiled and reused on the site. Leave the site in safe and clean condition.

D. All boulders from these operations shall be removed from the site and legally disposed of. All stumps and wood refuse shall be removed from the site and legally dispose of.

E. Dumping on the site shall not be permitted. Material to be removed shall be removed at the end of each day’s work, as it accumulates. Should the Contractor elect to continue work beyond normal working hours, material to be removed shall not be allowed to accumulate for more than 36 hours.

F. Burning on-site shall not be permitted.

3.4 Removal of Erosion Control

A. At the time of acceptance of lawns by the Owner, Contractor shall remove all remaining erosion control devices such as silt fence and hay bales and legally dispose of them off-site.

3.5 Restoration of Site Items

A. Wherever streets, pavements, curbs or other items within or outside the Contract Limit Lines have been excavated in fulfilling the work required under this Contract, the Contractor shall furnish and install all material at no cost to the owner to bring finish surfaces level with the existing adjacent conditions. All work shall be installed to match the existing conditions. Notify the proper authorities prior to restoring surfaces to assure conformance to existing requirements. All existing site items such as walks, stone walls, light posts, granite posts, granite curb, or any other site furniture or site items disturbed as a result of this work, shall be carefully stock piled and protected and reset in their original locations and conditions. Items damaged as a result of this work shall be replaced to match existing conditions.

END OF SECTION

SECTION 02200 EARTHWORK

PART 1 - GENERAL

1.1 References

A. The general documents, as listed on the Table of Contents, and applicable parts of General Conditions, shall be included in and made a part of this section.

B. Examine all drawings and all other sections of the specifications for requirements therein affecting the work of this trade.

C. Reference to Mass. DPW Specifications (Mass. SSHB) shall mean the Commonwealth of Massachusetts Department of Public Works “Standard Specifications for Highways and Bridges”, 1988 edition.

1.2 Scope of Work

A. Provide all labor, materials and supervision necessary to complete the work specified in this section as shown on the Contract Drawings, but not necessarily limited to the following:

1. Miscellaneous excavating and extra earth backfilling
2. Dewatering
3. Soil compaction
4. Sheeting, shoring and bracing
5. Sedimentation and erosion control
6. Supplying of earth and stone materials for fills and surface treatments, as necessary.
7. Excavating rock or boulders, existing pavement, foundations, or other underground structures, and pipelines.
8. Removing, stockpiling, reusing topsoil.
9. Excavating below grade, as specified, when necessitated by type of material encountered, as ordered by the Engineer.
10. Disposing of surplus and/or unsuitable materials. Such materials shall be hauled off the site.

1.3 Related Work Specified Elsewhere

A. The following items of related work are specified and included under other Sections of the Specifications:

1. Section 02100 - Site Preparation
2. Section 02513 - Paving and Surfacing
3. Section 02665 - Water Piping and Appurtenances

1.4 Special Conditions For Site Preparation and Earthwork Operation

A. Contractor shall refer to General Requirements, related to traffic control.

1.5 Definitions

A. The term “Soils Testing Representative” in this specification shall mean a competent inspector qualified by experience and training, employed by a Qualified Soils Testing

1.6 Examination of Site and Documents

A. It is hereby understood that the contractor has carefully examined the site and all conditions affecting work under this section. No claim for additional costs will be allowed because of lack of full knowledge of existing conditions.

B. Plans, surveys, measurements and dimensions, under which the work is to be performed are believed to be correct to the best of the Architect's knowledge, but the contractor shall have examined them for himself during the bidding period, as no allowance will be made for any errors or inaccuracies that may be found herein.

C. It is the responsibility of the contractor under this contract to do the necessary excavation, filling, grading and rough grading to bring the existing grades to subgrade and parallel to finished grades as specified herein and as shown on the Drawings for this work. The contractor shall visit the site prior to submitting a bid to become familiar with the extent of the work to be done under this section. All earth materials shall be included in the contractor's base bid.

1.7 Quality Control

A. The Owner will retain a Soils Testing Representative to perform on-site observation and testing during the following phases of the construction operations. The services of the Soils Testing Representative may include, but not be limited to the following:

1. Laboratory testing and analysis of fill and bedding materials specified, as required.

2. Observation, construction and performance of water content, gradation, and compaction tests at a frequency and at locations determined by the Soils Testing Representative.

B. The Soils Testing Representative's presence does not include supervision or direction of the actual work by the contractor, his employees or agents. Neither the presence of the Soils Testing Representative, nor any observations and testing performed by him, nor any notice or failure to give notice shall excuse the contractor from defects discovered in his work.

C. The Owner reserves the right to modify or waive Soils Testing Representative services.

1.8 Permits, Codes and Safety Requirements

A. All work shall conform to the drawings and specifications and shall comply with applicable codes and regulations.

B. Comply with the rules and regulations, laws and ordinances of the City of Cambridge, of the Commonwealth of Massachusetts, and all other authorities having jurisdiction. All labor, materials, equipment and services necessary to make the work comply with such requirements shall be provided without additional cost to the Owner.

C. Comply with the provisions of the Manual of Accident Prevention in Construction of the Associated General Contractors of America, Inc., and the requirements of the Occupational Safety and Health Administration, United States Department of Labor.

D. The contractor shall procure and pay for all permits and licenses required for the complete work specified herein and shown on the drawings.

E. The contractor shall not close or obstruct any street, sidewalk, or passageway unless authorized in writing by the owner, or by the City of Cambridge. The contractor shall so conduct his operations as to interfere as little as possible with the use ordinarily made of roadways, driveways, sidewalks, or other facilities near enough to the work to be affected thereby.

1.9 Disposition of Existing Utilities

A. Active utilities existing on the site shall be carefully protected from damage. When an active utility line is exposed during construction its location and elevation shall be plotted on the record drawings as described in this Section and both Owner and the utility owner notified in writing.

B. Inactive or abandoned utilities encountered during construction operations shall be removed or plugged or capped. The location of such utilities shall be noted on the record drawings and reported in writing to the owner.

1.10 Shoring and Sheeting

A. Provide shoring, sheeting and/or bracing excavations, as required, to assure complete safety against collapse of earth at sides of excavations.

B. If, at any place, sufficient or proper supports have not been provided, additional support shall be placed at the expense of the contractor. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.

C. All sheeting and bracing not ordered left in place shall be carefully removed in such a manner as not to endanger the construction of other structures, utilities, or property, whether public or private. All voids left after withdrawal or sheeting shall be immediately refilled with sand and rammed with tools especially adapted to that purpose, or otherwise compacted as directed to achieve the required density.

D. The portion of wood sheeting driven below mid-diameter of any pipe shall not be withdrawn, and under no circumstances shall any wood sheeting be cut off at a level lower than one foot above the top of pipe.

E. Shoring or sheeting shall not constitute a condition for which an increase may be made in the contract price with the exception that if the Owner directs in writing that certain shoring or sheeting shall be left in place, the contract price will be adjusted in accordance with the Contract Documents.

1.11 Drainage and Frost Protection

A. The contractor shall control the grading in areas under construction on the site so that the surface of the ground will properly slope to prevent accumulation of water in excavated areas and adjacent properties.

B. Should surface, rain or ground water be encountered during the operations, the contractor shall furnish and operate pumps or other equipment, and provide all necessary piping to keep all excavations clear of water at all times and shall be responsible for any damage to work or adjacent properties from such water. All piping exposed above surface for this use, shall be properly covered to allow foot traffic and vehicles to pass without obstructions.

C. Presence of ground water in soil will not constitute a condition for which an increase in the contract price may be made. Under no circumstances place concrete fill, lay piping or install appurtenances in excavation containing free water. Keep utility trenches free from water until pipe joint material has hardened.

D. Frost Protection: Do not excavate to full indicated depth when freezing temperatures may be expected, unless work can be completed to subgrade or piping can be installed and backfilled the same day after the excavation has been completed. Protect the excavation from frost if placing of concrete is delayed.

E. The contractor, free of expense to the owner shall keep the operations under this contract clear and free of accumulation of snow within the limits of contract lines as required to carry out the work.

F. No work shall be installed on frozen ground.

1.12 Dewatering

A. Based on subsurface investigations on adjacent properties conducted prior to this contract, it is anticipated that a portion of pipe installation and backfilling within the limits of the work will be carried out below existing groundwater levels. In soil bearing situations the contractor shall be required to implement ground water control measures to maintain the ground water level a minimum of one foot below all final excavation levels. The contractor shall furnish all plant, labor, equipment and materials and perform all operations in connection with handling groundwater and surface water encountered during construction of structures and placement of compacted granular fill. Pumping from perimeter open sumps may meet dewatering requirements.

B. Not less than 14 days prior to the scheduled start of work, the contractor shall submit his proposed method of dewatering and maintaining dry conditions, to the architect for approval. However, approval by the Owner of the contractor's proposed method of dewatering shall not relieve the contractor of responsibility for the satisfactory performance of the system. The contractor is responsible for correcting any disturbance of natural bearing soils or damage to structures caused by an inadequate dewatering system or by interruption of the continuous operation of the system as specified.

C. The contractor shall make the entire excavation for this work in-the-dry and shall not commence excavation below normal groundwater level until the water level, as indicated by groundwater observation wells, is a minimum of 12 inches below proposed bottom of excavation. The water level is to be maintained continuously at or below this level for the length of time specified hereinafter. The contractor shall construct all concrete work, and place all granular fill materials in-the-dry.

D. The contractor shall, at all times during construction, provide and maintain proper equipment and facilities to remove promptly and dispose of properly all water entering excavations, and keep such excavations dry so as to obtain a satisfactory undisturbed subgrade condition. Dewater shall be in operation until the fill or utility to be installed thereon has been completed to such extent that it will not be floated or otherwise damaged by allowing water levels to return to natural elevations.

E. The contractor shall discharge all pumped water away from the work area, and in accordance with all applicable local codes and laws. Requirements specified herein for Erosion and Siltation Control shall be met during this process.

F. All granular fill material shall be placed and compacted in-the-dry. The contractor shall dewater excavated areas as required to perform the work and in such a manner as to preserve and undisturbed state of the natural inorganic or other subgrade soils.

1.13 Disturbance of Dxcavated and Filled Areas During Construction

A. The contractor shall take the necessary steps to avoid disturbance of subgrade during excavation and filling operations. Methods of excavation and filling operations shall be revised as necessary to avoid disturbance of the subgrade, including restricting the use of certain types of construction equipment, i.e., the use of rubber tired vehicles or other equipment in areas where subgrade is above optimum moisture level and will become disturbed due to movement of vehicles.

B. All excavated or filled areas disturbed during construction that will not meet compaction requirements as specified herein shall be removed and replaced with gravel fill or crushed stone. Costs of removal of disturbed material and recompaction with gravel fill or crushed stone shall be borne by the contractor.

PART 2 - PRODUCTS

2.1 Materials

A. Crushed Stone: A product from a stone quarry, washed, graded and free of organic materials. One and one-half inch maximum stone size shall be used unless otherwise shown on the drawings.

U.S. SIEVE NO.	PERCENT PASSING BY WEIGHT	PERCENT PASSING BY WEIGHT
	3/4 Maximum Stone Size	12" Maximum Stone Size
2"	--	100
1-1/2"	--	95-100
1-1/4"	--	85-100
1"	100	35-70
_"	90-100	0-25
_"	Oct-50	--
3/8"	0-20	--
#4	0-5	--

B. Gravel Fill: Well-graded, natural sand and gravel conforming to the following gradations:

U.S. SIEVE NO.	PERCENT PASSING BY WEIGHT
4"	100
2" (utilities only)	100
1"	60-100
#4	25-85
#16	Oct-60
#50	30-Apr
#200	8-Mar

C. Ordinary Fill: Well-graded, natural inorganic soil approved by the owner and meeting the following requirements:

1. It shall be free of organic or other weak or compressible materials, of frozen materials, and of stones larger than six inches in dimension.

2. It shall be of such nature and character that it can be compacted to the specified densities in a reasonable length of time.

3. It shall be free of highly plastic clay, of all materials subject to decay, decomposition, or dissolution, and of cinders or other materials which will corrode piping or other metal.

4. It shall have a minimum dry density of not less than 115 pounds per cubic foot.

5. Material from excavation on the site may be used as ordinary fill if it meets the above requirements.

PART 3 - EXECUTION

3.1 General Excavation

A. Excavate all materials encountered to allow construction of the proposed structures, utilities and site work as shown on the drawings and as hereinafter specified. Attention is called to notes on drawings and notes on details and to the requirements contained therein which may affect the work under this section.

B. Excavate 1) to levels shown on drawings for trenches, utilities and structures, 2) as required to provide working clearance and to allow adequate inspection, and 3) to subgrades of surface treatments as specified herein below and as shown on drawings.

C. Remove from the site and legally dispose of all debris and other excavated material not needed for, or unsuitable for, fill except as otherwise specified herein. Remove all materials subject to rot or attack by termites.

D. All excavated materials which, in the opinion of the Owner, are not suitable for fill or backfill, shall be removed from the site and legally disposed of at no cost to the Owner.

E. Unanticipated Soil Conditions

1. If unsuitable bearing materials are encountered at the specified depths, carry excavation deeper and replace the excavated material with compacted gravel fill or lean concrete as directed by the Owner.

2. Removal of such material and its replacement as directed will be paid for as extra compensation in quantity approved by the Owner. Only changes in the work authorized by the Owner in writing shall constitute an adjustment in the contract price.

3. Material that is above or below optimum moisture for compaction of the particular material in place as determined by the Soils Representative and is disturbed by the contractor during construction operations so that proper compaction cannot be reached shall not be construed as unsuitable bearing materials. This material shall be removed and replaced with lean concrete or compacted gravel fill at no additional charge.

F. Excessive Excavation: If any part of the general or trench excavation is carried, through error, beyond the depth and the dimensions indicated on the drawings or called for in the specifications, the contractor, at his own expense, shall furnish and install compacted gravel fill, concrete, or take other remedial measures as directed by the owner to bring fill material up to the required level or dimension.

3.2 Trench Excavation

A. Excavate as necessary for water, related structures and appurtenances, and for any other trenching necessary to complete the work.

B. Definitions:

1. Trench shall be defined as an excavation in which the bottom width does not exceed seven feet and the width does not exceed twice the depth. All other excavations shall be defined as open excavation. Refer to drawings for any special trenching conditions for utilities, structures, etc.

2. The words “invert and invert elevation” as used herein means the elevation at the inside bottom of pipe or channel.

3. The words “bottom of the pipe” as used herein mean the elevation at the base of the pipe at its outer surface.

C. In general, machine excavation of trenches will be permitted with the exception of preparation of pipe beds (trench bottom up to pipe invert) which will be hand work. Excavate by hand or machine methods to at least six inches below the bottom of all utilities or as indicated on drawings.

D. Trench excavation shall comprise of the removal of all materials encountered. All excavated materials not required or unsuitable for backfill shall be removed and legally disposed of off the site. The banks of trenches shall be cut as near vertical as practicable to the extent allowed by OSHA.

E. It is called to the attention of the contractor that there are utilities and other underground pipes along the course of the work. Information shown on the drawings as to location is from best available sources, but no guarantee is inherent or to be assumed that such information is accurate or complete. The contractor shall exercise special care during his operations to avoid injury to underground utilities and structures. When necessary, the contractor shall, at his own expense, preserve and project from injury all property either public or private along and adjacent to the line of work, and be responsible for and repair any and all damage and injury thereto, arising out of or in consequence of any act or omission of the contractor. All existing pipes shall be supported in place or otherwise protected from injury, or shall be restored to at least as good condition as that in which they were found immediately prior to start of work.

F. The contractor shall provide, at his own expense, suitable bridges over trenches where required for accommodation and safety of the traveling public and as necessary to satisfy the required permits and codes.

G. Trenches shall be excavated to the necessary width and depth for proper laying of pipe or other utility and shall have vertical sides or slopes as required by codes. Minimum width of trenches shall provide clearance between the sides of the trench and the outside face of the utility. Maximum trench sizes are as shown on the drawings or as specified herein. The depth of the trench shall be six inches below the bottom of the pipe barrel or respective utility. If the existing soil is found not suitable, the owner may order extra excavation (defined herein) below the bedding grade.

H. Utilities shall not be laid directly on ledge, boulders, or other hard material. This material shall be removed as specified herein within trench limits, and within vertical planes to one foot outside of structure walls. Backfill will be with the specified fill places in eight inch lifts and thoroughly compacted. If hand guided compaction equipment is used, fill shall be placed in six inch lifts.

I. Coordinate all utility and trench backfillings with the trades involved.

3.3 Filling and Grading

A. Samples and Testing:

1. All fill materials and their placement shall be subject to quality control testing. A qualified Soils Testing Laboratory will be selected and paid for by the Owner except that the contractor will bear cost of testing materials which fail to conform to specifications. Test results and laboratory recommendations will be available to contractor. All sieve analysis for conformance of on-site and off-site fill materials to be used on the work shall be done by means of a mechanical wet sieve analysis and in accordance with ASTM D-422.

2. Field density tests will be made by the soils Testing Representative in accordance with the Method of Test for ASTM Designation: D1557, Method C to determine the adequacy of compaction; the location and frequency of such field tests shall be at the Soils Testing Representative's direction.

3. The contractor shall notify the owner or his designated representative when an area is ready for compaction testing. This notification shall be 48 hours in advance of final compaction so that the soils testing laboratory can be adequately notified to take compaction tests.

4. The Owner and Soils Testing Laboratory shall have the right to observe the installation of all controlled compacted fills.

5. Tests of material as delivered may be made from time to time. Materials in question may not be used, pending test results. Tests of compacted materials will be made regularly. Remove rejected materials and replace with new, whether in stockpiles on in-place.

6. Cooperate with Soils Testing Laboratory in obtaining field samples of in-place materials after completion. Furnish incidental field labor in connection with these tests. The contractor will be informed by the Soils Testing Representative of areas of unsatisfactory density which may require improvement by removal and replacement, or by scarifying, aerating, sprinkling (as needed), and recompaction prior to the placement of the new lift. No additional compensation shall be paid for work required to achieve proper compaction.

7. In no case will frozen material be allowed for use as fill, backfill, or rough grading material.

8. The Soils Testing Representative's presence does not include supervision or direction of the actual work by the contractor, his employees, or agents. Neither the presence of the Soils Testing Representative nor any observations and testing performed by him shall excuse the contractor from defects discovered in his work.

B. Placing, Spreading, and Compacting Fill Material:

1. Fill materials are to be placed as designated herein and as indicated on the contract drawings.

   a. Crushed stone shall be placed as follows and compacted as directed by the owner:

      1) For erosion control purposes.
      2) 3/4 inch size stone shall be used for bedding under utility structures.
      3) Where shown on drawings or as directed by the owner.

   b. Gravel Fill shall be placed as follows and compacted in six inch (compacted thickness) lifts to a minimum of 95% maximum dry density.

      1) As a base course under all bituminous roadway and walkway pavements, unless otherwise shown on drawings.
      2) As a bedding material around water pipes.
      3) As backfill around all catch basins, manholes and utility structures.
      4) Where otherwise shown on the drawings.
      5) Where granular fill is called for or shown on the drawings.

   c. Ordinary Fill shall be placed as follows and compacted in eight inch (compacted thickness) lifts to a minimum of 95% in the pavement areas.

      1) In general site fill areas.
      2) Above select bedding around pipes as backfill in trenches, up to subgrade of surface treatment.
      3) Wherever gravel fill, crushed stone, sand fill, or topsoil is not required herein or on the drawings.

2. The fill material shall be placed in uniform horizontal layers that when compacted shall not exceed six or eight inches as required. Each layer shall be spread evenly and shall be thoroughly mixed during the spreading to obtain uniformity of material in each layer. So far as practicable, each layer of material shall extend the entire length and width of the area being filled.

3. When the moisture content of the fill material is below that specified by the Soils Testing Representative, water shall be added until the moisture content is as specified.

4. When the moisture content of the fill material is above that specified by the Soils Testing Representative, the fill material shall be aerated by blanding, mixing, or other satisfactory methods until the moisture content is as specified.

5. After each layer has been placed, mixed and spread evenly, it shall be thoroughly compacted to the specified density. Compaction shall be continuous over the entire area and the equipment shall make sufficient passes to ensure that the desired density is obtained.

C. Backfilling of Trenches

1. Areas to be backfilled shall be free of construction debris, refuse, compressible or decayable materials and standing water. Do not place fill when temperature is below 30ºF and when fill materials or layers below it are frozen.

2. Requirements of description, placement, compaction and spreading of fill materials as specified herein shall be applicable to backfilling operations.

3. Gravel fill shall be used as backfill around manholes and other structures.

4. Backfilling utilities shall not commence until construction below finish grade has been approved, and the excavation cleaned of trash and debris. Avoid damage to the walls and to dampproofing or waterproofing and other work in place. Allow seven days from the date of application of waterproofing before backfilling. Stones larger than four inches maximum dimension shall not be permitted in the upper six inches of fill or within six inches of structures.

5. Do not commence backfilling operations of utility trenches until all piping, conduit, etc., has been installed, tested, and approved and the locations of all pipe and appurtenances have been recorded. Backfill carefully by hand around pipe to depth of one foot above top of pipe using material specified herein, and tamping firmly in layers not exceeding six inch layers, compacting by hand rammers or mechanical tampers. When a manufacturer of utility line materials and methods other than those specified herein, such requirements shall govern, providing the finished work equals or exceeds the result obtained by the materials and methods specified herein. Water mains shall be hand backfilled to a minimum cover of 18 inches before machinery can be used to backfill trench.

6. Gravel bedding or sand bedding will be required below all pipes unless otherwise shown on drawings or specified herein. Crushed stone is required under utility structures where shown on the drawings. Gravel bedding, sand bedding or crushed stone shall be placed to the full width of the trench and under utility structure foundations as indicated on the drawings. After a pipe is bedded, the trench shall be filled to the centerline of the pipe with gravel fill or sand bedding except at the joint. After the joint is inspected, that portion shall be filled in with gravel or sand bedding. Material under and around the pipe shall be carefully and thoroughly tamped.

7. From the centerline of the pipe to a point six inches above the top of the pipe and backfill shall be gravel fill or sand placed by hand and hand tamped. Above this point, backfill shall be material as specified. This backfill shall be placed in layers eight inches deep and each layer shall be compacted with mechanical tampers to not less than 95% of maximum density at optimum moisture content of the material. This backfill shall be carried up to the bottom of materials specified to be placed for surfacing or topsoiling and seeding requirements.

D. Compaction Equipment: Compaction shall be accomplished by vibratory rollers, multiple-wheel pneumatic-tired rollers or other types of approved compacting equipment. Equipment shall be of any such design that is will be able to compact the fill to the specified density in a reasonable length of time. All compaction equipment shall be subject to the approval of the owner of his designated representative.

E. Compaction Requirements:

1. Fill material shall be compacted to the following densities:

   a. Under paved areas - 95%
   b. Percent of maximum dry density of the material at optimum moisture content as determined by Methods of Test for ASTM Designation D-1557-70, Method C.

3.4 Deficiency of Fill Material

A. Provide required additional fill material if a sufficient quantity of suitable material is not available from the required excavation on the project site at no additional cost to the Owner.

3.5 Rough Grading

A. Rough grading shall include the shaping, trimming, rolling and finishing the surface of the sub-base, shoulders and earth slopes, and the preparation of sub-base for paved surfaces. The grading of shoulders and sloped areas may be done by machine methods. Grading of subgrades for paved areas shall be finished at the required depth below the parallel the proposed surface without 3/8 inch in ten feet tolerance.

B. If, during the progress of rough grading work, water pipe, sewer, conduit, drain, or other construction is damaged due to operations under this contract, the contractor shall repair all such damage at no additional cost to the owner and restore damaged areas to their original condition.

C. Do all other cutting, filling and rough grading to the lines and grades indicated on the drawings. Grade evenly to within the dimensions required for finished grades shown on drawings. No stone larger than four inches in largest dimension shall be placed in upper six inches of fill.

D. Grades shall be brought below finished grades in accordance with the various depths specified hereinbelow:

1. Paved Areas - Bottom of base course as shown on drawings.

E. No rubbish of any description shall be allowed to enter fill material. Such material shall be removed from the site.

F. Complete the grading operations after the building has been finished, the utilities installed, site improvements constructed, and all materials, rubbish and debris removed from the site. Leave subgrade for lawns clean at required grades. There must be sufficient grade staking to witness correct lines and grades.

3.6 Surplus Fill Material

A. Surplus fill which is not required to fulfill the requirements of the contract shall be removed from the site.

3.7 Dust Control

A. The contractor shall take all necessary measures and provide equipment and/or materials to minimize dust from rising and blowing across the site and also to control surface water throughout the operation so that it does not run onto paved ways without being filtered. In addition, the contractor shall control all dust created by construction operations and movement of construction vehicles, both on the site and on paved ways. Provide additional crushed stone where necessary to provide traps or filters for runoff water carrying sediment. Provide temporary swales and interceptor ditches to control surface runoff water where necessary.

B. For all work and dust control done within rights-of-way, in addition to watering, sweeping and other methods, the contractor shall apply calcium chloride in the required amounts to properly control dust. These amounts shall be approved by the Engineer prior to applicable.

3.8 Restoration of Site Items

A. Wherever streets, driveways, sidewalks, lawns and other items within or outside the Contract Limit Lines have been excavated in fulfilling the work required under the Contract, the contractor shall furnish and install all material at no cost to the owner to bring finish surfaces level with the existing adjacent conditions. All work shall be installed to match the existing conditions. Notify the proper authorities prior to restoring surfaces to assure conformance to existing requirements.

END OF SECTION

SECTION 02221 - UTILITY TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 Description

A. The work of this section consists of trenching and backfilling for the construction and installation of pipelines, conduits, and cables. All trenching will be open cut. Backfilling shall comply with requirements of the Departments of Public Work.

1.2 Definition

A. Materials used in backfill, as shown in trench details, are defined as follows:

B. Bedding (BD): When rock, unstable material, or wet trench is encountered at the excavated grade for utility installation, bedding is required. Materials shall be predominantly sand and gravel, having a plasticity index less than 6. Bedding may be omitted if, in the opinion of the Contracting Officer, the excavated trench bottom will adequately support and not damage the utility line.

1. BD-1: Gradation as follows:

Sieve Size	Percent Passing
No. 4	100
No. 8	55-85
No. 40	15-30

2. BD-2: Gradation as follows:

Sieve Size	Percent Passing
1/2-inch	100
No. 4	50-80
No. 40	10-25

3. BD-3: Gradation as follows:

Sieve Size	Percent Passing
1-1/2-inch	100
1/2-inch	45-75
No. 40	10-25

1.3 Quality Assurance

A. All compaction testing and gradation analysis will be arranged and paid for by the Government. Contractor shall be present when samples of bedding, select backfill, and backfill materials are gathered for analysis.

B. All references to percent of maximum density will be as determined by ASTM D698-78, Method C, at a moisture content determined to be suitable for such density. Moisture-density curves will be prepared in a certified soils testing laboratory.

C. In-Place Soil Density Testing: Procedures used by the Contracting Officer will be in accordance with ASTM D1556-82, Density of Soil In Place By the Sand-Cone Method, or ASTM D2922-81, Density of Soil and Soil-Aggregate In Place By Nuclear Methods (Shallow Depth). Contracting Officer will perform at least one test within each backfill material zone (BD, SB, BF) at the following maximum intervals:

1. Vehicular Traffic Areas: 50 linear feet of trench. Testing at more frequent intervals may be performed at the discretion of the Contracting Officer.

1.4 Submittals

A. Written procedure for trench dewatering and disposal of fluidized materials removed.

B. Written description of barricading, shoring, cribbing, bracing, and sloping precautions.

C. Provide certifications of gradation analysis requirements for all gravel materials.

1.5 Project Conditions

A. Obtain all required permits and licenses before installing utilities under existing roads and follow the rules and requirements of the authority having jurisdiction.

B. Arrange construction sequences to provide the shortest practical time that the trenches will be open to avoid hazard to the public, and to minimize the possibility of trench collapse.

1.6 Excavation Classification

A. Regardless of the nature of material excavated, all excavation will be considered unclassified.

1.7 Hand Excavation

A. Contracting Officer will direct the performance of hand excavation within the drip line of selected trees shown on the drawings.

PART 2 - PRODUCTS

2.1 General

A. All backfill material shall meet the City of Cambridge requirements.

2.2 Materials for Backfilling

A. Furnish required bedding, select backfill, and backfill materials listed under the appropriate types of utility line in the sections to which this work relates.

2.3 Utility Line Marking

A. All utilities shall be marked for location and identified by marking tapes, as specified in Section 02229.

PART 3 - EXECUTION

3.1 Trench Excavation

A. Trenching Guidelines: Excavate the trench to the approximate level of the top of the utility line to be installed, using adequate trench width and side slopes to safely accommodate worker access. Continue excavating for the utility line, to a width not greater than is shown on the appropriate trench detail. Do not scour side of trenches.

1. Rocky Trench Bottom: Where ledge rock, hard pan, boulders, or sharp-edged materials are encountered, overexcavate a minimum depth of 6 inches below the bottom of the utility exterior wall to permit adequate bedding preparation. The installed utility shall have at least 6 inches of clearance from any rock protrusion.

2. Unstable Trench Bottom: Secure approval of depth of over-excavation and stabilization method. For wet trench construction, use approved method of dewatering through diversion, damming and pumping, well points, or underdrain systems. Dispose of removed fluidized materials as approved. Use BD-3 material to build a suitable foundation to within 6 inches of finished utility grade, prior to bedding with the specified material. Compact layers to 95 percent of maximum density in not greater than 6-inch layers. Do not proceed with utility installation until wet trench and unstable conditions are under control.

3. Hand Excavation: Perform hand excavation of trenches dug within the drip line of selected trees as shown. Carefully excavate around all roots 2 inches in diameter and larger to ensure against damage.

B. Paved Areas: Cut existing pavement full depth to a true line before excavation, as shown, and maintain the edge suitable for repaving.

3.2 Shoring and Sheeting

A. Construct and maintain all shoring, sheeting, and slope lay-back necessary to protect the excavation, as needed for the safety of the employees and as required by applicable State and Federal laws.

B. For trenches over 5 feet deep, provide suitable barricades for worker protection. When work area is left open and unattended by Contractor, provide suitable barricades for public safety, regardless of trench depth.

C. For trenches over 4 feet deep, provide suitable exit means in accordance with applicable provisions of OSHA.

D. Do not remove timber or sheeting if it is in a compacted zone. Instead, trim it off at a safe level above that zone.

E. As directed, remove all other sheeting and shoring when safe to do so.

3.3 Backfilling

A. Compaction: Use vibratory compactors for sands and gravels (noncohesive soils). Use mechanical tampers for sand and gravel containing a significant portion of fine-grained material, such as silt and clay (cohesive soils). Hand tamp around pipe or cable to protect the lines until adequate cushion is attained. Puddling or water flooding for consolidation of backfill or compaction by wheel rolling with construction equipment will not be permitted.

B. Bedding: Compact the specified material to 95 percent of maximum density to the finished utility grade.

C. Utility Installation: Shape the trench bottom to ensure uniform contact with the full length of the installed line and remove any sharp-edged materials that might damage the line. Compaction shall be maintained beneath the line.

D. Select Backfill: Fill by hand placement around the utility to just over half depth, and compact in a manner to ensure against lateral or vertical displacement. Place select backfill to 12 inches above the utility line by hand placement in not more than 6-inch layers. Compact each layer to 95 percent of maximum density.

E. Backfill: Place and compact the specified material as follows:

1. Vehicular Traffic Areas: Fill and compact in 8-inch maximum layers to 95 percent of maximum density.

3.4 Dewatering:

A. The Contractor shall provide and maintain at his own expense ample means and equipment such as pumps, drains, sumps and wellpoints for dewatering and properly disposing of water entering the trenches, excavations, and other parts of the work.

B. Prior to excavation, lower the water table in the trenches and excavations a minimum of 2 ft. below the elevation of the required subgrade and maintain this until completion of any permanent construction or filling or backfilling of the excavated area.

C. Dewatering shall be done in an approved manner such that the subgrade can be trimmed, foundation materials, pipe or concrete placed in the dry without disturbing bearing materials, and water from the excavation shall be disposed of in such manner that will cause no injury to property or inconvenience to the public.

3.5 Excavation:

A. Open cut from surface, as shown on the Contract Drawings, to elevations required for the installation of permanent construction in such manner as not to disturb the subgrade below such elevations.

B. In the event that the subgrade is disturbed, the disturbed soils shall be excavated. Filter fabric shall be placed over the undisturbed subgrade followed by placement of stone bedding as specified in Section 3.9 of this Specification.

3.6 Surface Finish Work

A. Paved Areas: Replace removed paving and base course with new material of equal or better quality and of the same texture and color as the adjacent paved areas. Saw cut pavement edge to a true line and broom as needed prior to paving.

END OF SECTION

SECTION 02229 - UTILITY LINE MARKING

PART 1 - GENERAL

1.1 Description

A. The work of this section consists of furnishing and installing utility line marking.

1.2 Submittals

A. Under the provisions of the General Conditions.

B. Samples: 24-inch strips of tape and 2 markers.

C. Certification that the materials used in the tape fabrication meet the requirements of this section.

D. Installation procedure if the cable is installed by plowing.

PART 2 - PRODUCTS

2.1 Marking Tape

A. Capable of being inductively detected electronically.

B. Construction: Metallic foil laminated between two layers of impervious plastic film not less than 2 inches wide. The adhesive shall be compatible with the foil and film. Total thickness of tape shall not be less than 0.005 inch (5 mil).

C. Film: Inert plastic. Each film layer shall be not less than 0.0005 inch thick (0.5 mil).

D. Foil: Not less than 0.0005 inch thick (0.5 mil).

E. Imprint: 3/4-inch or larger bold black letters.

F. Legend: The buried utility line tape shall be identified with imprint such as “Caution: Sewer Line Below” and the identification repeated on approximately 24-inch intervals.

G. Background Color: APWA color code and as specified below:

Color	Utility
Safety Precaution Blue	Water System

H. Detectable marking and warning tape shall be as manufactured by Lineguard, Inc., Wheaton, Illinois; Reef Industries, Inc., Houston, Texas; Thor Enterprises, Inc., Sun Prairie, Wisconsin; or approved equal.

PART 3 - EXECUTION

3.1 Marking Tape

A. Install tape in backfill directly over each buried utility line as shown. Place tape by plowing or place it during the final backfilling operation.

B. Where utilities are buried in a common trench, identify each line by a separate warning tape. Bury tapes side by side directly over the applicable line.

END OF SECTION

SECTION 02285 - RODENT CONTROL

1. **Rodent Control:** This section applies to rodent control which is related to demolition work and Construction Contracts. This section does not relate to M.I.T.'s on-going rodent, pest, and pigeon control programs.

2. **Acceptable Rodent Control Techniques:** M.I.T. has an on-going rodent control program which is contracted annually according to bid documents and specifications prepared by M.I.T.'s Environmental Medical Service. Rodent control techniques employed during demolition must be coordinated with M.I.T.'s on-going rodent control program and approved by M.I.T.'s Environmental Medical Service.

3. **Submittals:** Information on rodent control poisons and techniques must be submitted to the M.I.T. Environmental Medical Service offices for approval prior to use.

4. **Warnings:** If poison bait is used, require that signs be posted to warn building occupants against handling the bait. In residential buildings, especially where children may be present, special educational sessions may be required.

END OF SECTION

SECTION 02300 - EROSION CONTROL

PART 1 - GENERAL

1.1 Scope

A. This section establishes requirements for that phase of environmental controls pertaining specifically to erosion control during construction. Provisions pertaining to other aspects of environmental controls during construction. See also Section 02100, SITE PREPARATION.

1.2 General

A. Work under this Contract shall comply with applicable Federal, State, and local laws and regulations concerning environmental pollution control and abatement.

B. Erosion and siltation shall be prevented during construction. Proposed methods, materials to be employed, and schedule for effecting erosion and siltation control and preventing erosion damage shall be submitted for approval.

C. Excavations, pits, trenches, and other Work areas shall be maintained free of water at all times, including water resulting from backing up of drain and sewers.

1. Equipment necessary to control surface and ground water shall be supplied as required.

2. Pumping equipment shall be adequate to remove all hydrostatic pressure from all parts of work until sufficient strength and weight have been developed thereby to protect Work from displacement and other damage.

D. Ground water level shall at all times be maintained at a level sufficiently below excavation level to provide stable working platform. Ground water shall be controlled to avoid adverse effects on established ground water elevations of adjacent sites.

E. Drainage water shall be disposed of by means which will prevent erosion and other damage to the Work and surrounding areas.

1.3 Materials

A. The products of specific manufacturers have been specified below to establish type and quality required. Equivalent, nationally distributed products of other manufacturers will be equally acceptable, subject to the approval of the Owner/Engineer.

B. Silt fences shall be made with "Typar" fabric, manufactured by the Dupont Company, Wilmington, Delaware. Silt fences may be employed in place of staked hay bales.

1.4 Construction

A. Cut and fill slopes shall be protected to prevent erosion. The slopes shall be protected with permanent landscaping material when the erosion exposure period is expected to exceed six (6) months. Temporary slope protection shall be employed when the erosion period is expected to be less than six (6) months.

B. Siltation checks shall be installed as early as possible in the construction sequence, and shall be maintained thereafter as follows:

1. The sediment behind the siltation control device shall be checked twice each month and after each heavy rain. Silt shall be removed if more than 3 in. (75mm) deep.

2. The condition of the siltation control device shall be checked twice each month. Damaged and/or deteriorated items shall be replaced. Siltation control devices shall be maintained in place and in effective condition.

3. Hay bale siltation checks shall be installed in close contact, with stakes driven essentially flush with the top of the bale. Bales shall be maintained or replaced to maintain both their effectiveness and essentially their original appearance. Underside of bales shall be kept in close contact with the earth below at all times as required to prevent water from washing beneath the bales.

4. Siltation checks installed under the Site Preparation contract shall be replaced as required and maintained under this section of the specification.

C. Culverts and drainage ditches shall be kept clean and clear of obstructions during the construction period.

D. Dust shall be controlled by spraying the ground with water as required.

END OF SECTION

SECTION 02513 - PAVING AND SURFACING

PART 1 - GENERAL

1.1 References

A. The General Documents, as listed on the Table of Contents, and applicable parts of GENERAL CONDITIONS shall be included in and made a part of this Section.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the Work of this trade.

C. Reference to Mass. DPW Specifications (Mass. SSHB) shall mean the Commonwealth of Massachusetts Department of Public Works "Standard Specification for Highways and Bridges," 1988 edition.

1.2 Scope of Work

A. Provide all labor, materials and supervision necessary to complete the work specified in this Section as shown on the Contract Drawings, but not necessarily limited to the following:

1. Bituminous patching over fire waterline trenches as may be affected by work of the Contract.

B. Uniformed Police: The Contractor shall furnish uniformed police officers to handle traffic at locations as directed by the **Massachusetts Institute of Technology**, as appropriate. As provided by Section 34B of Chapter 149 of the General Laws, the Contractor shall pay, to any reserve officer employed by him in any area within **MIT's** jurisdiction, the prevailing rate of wage paid to police officers appropriate to the jurisdiction. This paragraph shall specifically apply to all work required within the public ways **MIT**, as well as within areas which are necessary for the maintenance of MIT activities.

1.3 Related Work Specified Elsewhere

A. The following items of related work are specified and included under other Sections of the Specifications:

1. Trenching and backfilling, base course construction, grading, compaction to line and grade, sheeting, dust control, removing existing concrete pavement – Section 02200, EARTHWORK.

2. Water piping - Section 02665, WATER PIPING AND APPURTENANCES.

B. The work of this Section shall be coordinated with that of other trades affecting, or affected by, this work, as necessary to assure the steady progress of all work of the Contract.

C. In addition to the specific guarantee requirements of the Agreement and General Requirements, the Contractor shall obtain materials furnished under this Section where such guarantees are offered in the manufacturer's published product data. All these guarantees shall be in addition to, and not in lieu of, other liabilities which the Contractor may have by law or other provisions of the Contract Documents.

PART 2 - PRODUCTS

2.1 Materials

A. In general, all bituminous and incidental materials used in the work shall conform to the requirements of the Mass. SSHB, 1988 edition, unless specifically stated otherwise herein.

B. Bituminous concrete surfacing materials shall conform to Section 460, Class I Bituminous Concrete paving of Mass. SSHB. Gradations of mix will be as directed by the Architect to suit the use intended.

C. Bituminous cold patching materials shall conform to Section 472, "Bituminous Concrete for Patching" of said Mass. SSHB.

D. Tack coating shall be done with an approved bituminous tacking material spread along the contact areas at all joints.

E. Joint sealing shall be done with hot bituminous or other approved sealing compounds poured onto the rolled joint followed by a fine sand covering.

PART 3 - EXECUTION

3.1 General

A. In general, all construction methods shall conform to the applicable provisions of the Mass. SSHB, 1988 edition, unless specifically stated otherwise herein.

3.2 Installation

A. Gravel bases shall be prepared to receive bituminous concrete pavement by grading and rolling to the proposed subgrades. Wetting of the gravel may be required if necessary to maintain compaction and grading. Rolling shall be done with a roller weighting the same as specified for the proposed pavement. Crowning of the base gravel up to one inch will be required to provide for additional trench settlement. Existing paved surfaces on which new pavement is to be placed shall be swept clean of all debris and loose materials.

B. All joints at existing pavement cuts, berms, roadway castings, etc. shall be tack coated prior to placement of new surfacing against them. Cut joints at existing and new top pavement surfaces shall be sealed with bitumen and sand. This includes roadways, sidewalks, driveways and all other pavements.

C. Cold patch when directed by the Owner shall be placed over the backfilled trenches and compacted by mechanical tamping or approved wheel rolling methods to provide a compacted depth of two inches. Prior to placing the cold patch, the backfill shall be graded to provide a one inch crown.

D. The Contractor shall be responsible for keeping the surface of all the patched trenches level with the existing pavements in a safe and satisfactory condition for vehicular use until the contract and/or placement of the permanent patching has been completed.

E. Immediately upon satisfactory testing of the pipes, the Contractor shall recut the edges of the previously cut pavement damaged during excavation and backfilling and grade the previously placed gravel base courses to receive the specified thickness of Type I Bituminous Concrete pavement. Bituminous concrete patch shall match existing pavement at a minimum and shall in no case be less than two inch Binder Course and one inch Top Course. This material may be hand or machine placed within the trench to provide a one inch crown and the minimum compacted specified thickness of pavement when rolled with an eight ton roller. Roadway castings within the trench shall be set to receive the final surfacing and be temporarily ramped for safety.

F. Sidewalks, driveways, walks and other miscellaneous bituminous paved surfaces disturbed by the work shall be replaced in as good a condition as existed prior to the work.

G. Existing public sidewalks shall be cut at right angles to their edges 12 inches beyond the nearest trench wall. The gravel base shall be fine graded and rolled. Type I bituminous concrete shall be placed in two, one inch layers, each layer being compacted with a roller weighing a minimum of three tons. Edges shall be straight uniform.

H. Driveways, if any, disturbed by the work shall be replaced to their existing thicknesses. Existing pavement shall be cut at right angles to edges and all joints shall be tack coated and sealed. Where conditions warrant (short length, flat angle crossings, etc.), the Owner may require a one inch overlay over the entire driveway or a portion thereof.

I. Berms shall be machine formed to match existing configurations in long runs and may be hand formed in short runs (four feet or less).

J. Private walks shall be replaced to the existing depths and widths in segments determined by the Owner.

K. All work within MIT property shall be in accordance with the following requirements:

1. Cutting by mechanical means: all pavement surfaces shall be cut by an approved mechanical means before any excavation is started to insure against unnecessary damage to pavement.

2. Excavation shall be done in a safe manner so as to create a minimum amount of obstruction to pedestrian or vehicular traffic.

3. Backfilling Trenches: Suitable material of a stable nature shall be used and placed in six-inch layers and thoroughly compacted to 95% of the maximum dry density by mechanical means. Top 12 inches of backfill shall be compacted gravel.

4. Temporary Patch: All trenches shall be resurfaced with a temporary patch at the end of each working day with a minimum of thickness of three inches of bituminous concrete. This should be allowed to remain for a minimum period of 60 days, a maximum period of 90 days and be maintained by the Contractor. No permanent resurfacing shall be done without permission from the Owner. He shall be the sole agent to determine whether the trench is ready for permanent resurfacing. The Contractor shall be required to thoroughly clean all road surfaces at the end of each day.

5. Permanent Resurfacing:

   a. All trenches shall be cut back one foot on each side from original cut by an approved mechanical means.

b. 12 inches of approved gravel placed in two layers and compacted by mechanical means to 95%.

c. Three inches of bituminous concrete placed in two layers of two inch binder and 1-1/2" inch top and rolled with a powered roller having a weight of five tons or more. Existing pavements thicker than three inches shall be replaced to an equal thickness using materials as similar as possible to the existing (concrete, crushed stone with bituminous concrete, etc.).

d. Before placing bituminous concrete, all joints shall be satisfactorily emulsified and again after placing top course of bituminous concrete, all joints shall be emulsified and sanded using screened sand.

6. Curbs shall be restored completely.

END OF SECTION

SECTION 02525 - CURBS

1. **Granite Curbs:** Comply with Commonwealth of Massachusetts Department of Public Works Standard Specifications for Highways and Bridges sections M9.04.0, M9.04.01 and M9.04.06 for granite curb type VA4. When the curb is in a public way, comply with City of Cambridge requirements including installation details. Granite curbs are the first choice and should be used wherever possible.

2. **Precast Curbs:** Precast concrete curbs should not be used.

   A. Precast Concrete Wheelstops: See Section 02500 - Paving.

3. Bituminous or Asphalt Curbs: Since these curbs can be easily damaged by normal traffic and especially snow plows, the use of bituminous curbs is discouraged.

4. Barrier Free Accessibility: Remember to show code complying barrier free curb cuts at specific locations, i.e. diagonal or across from each other. Refer to ADA and the Mass. Architectural Access Board for specific requirements for curb cuts.

END OF SECTION

SECTION 02800 - SITE IMPROVEMENTS

1. **Reviews:** All sitework plans, landscape plans, and catalog cuts for each site improvement product must be reviewed and approved by the M.I.T. Planning Office, the M.I.T. Grounds Department Manager, M.I.T. Utilities and Engineering and the M.I.T. Project Manager.

2. **Waste Receptacles:** Provide non-combustible or fire-retardant containers which have non-corrosive removable liners. Lids, if used, must be cabled to the container. Architectural or ornamental waste receptacles must be anchored to the ground. Waste receptacles must be approved by the M.I.T. Planning Office and the Grounds Services Manager. There are currently no standards for M.I.T. trash receptacles.

3. **Bicycle Racks:** Shelter bike racks wherever possible. Provide the type of rack approved by the M.I.T. Grounds Department Manager and M.I.T. Planning Office; some racks may need to be anchored to the ground.

4. **Irrigation Systems:** Provide irrigation systems for all new and renovated landscaped areas. Preferred irrigation system controller and timeclock location is in grounds-keeping equipment room. Refer to Section 02810 - Irrigation for equipment requirements. Irrigation systems must be approved by the M.I.T. Planning Office and the Grounds Services Manager.

5. **Benches:** Provide benches that require no painting or regular maintenance. Provide the type of bench approved by the M.I.T. Grounds Department Manager and M.I.T. Planning Office; some benches may need to be anchored to the ground.

6. **Wooden Fences and Chain Link Fences:** Review with the M.I.T. Grounds Department Manager and M.I.T. Planning Office. Refer to Division 1 - Uncommon Ordinances for information on fences.

7. **Site Artwork and Sculptures:** Review with the M.I.T. Grounds Department Manager, the M.I.T. Visual Arts Committee, M.I.T. Planning Office, Office of the Associate Provost for the Arts, and M.I.T. Safety Office. In areas with pedestrian or recreational activity, sculptures and artwork with sharp edges or points should be avoided or suitable barriers must be provided.

8. **Playground Equipment:** Review with the M.I.T. Grounds Department Manager, the M.I.T. Housing Department, M.I.T. Planning Office and M.I.T. Safety Office.

9. **Outdoor Bleachers:** Review with the M.I.T. Grounds Department Manager, M.I.T. Planning Office and M.I.T. Safety Office. Extruded aluminum or other low maintenance bleachers are preferred; avoid wooden seats since they require excessive maintenance and are typically not fire-resistant.

10. **Outdoor Tennis Courts and Nets:** Review with the M.I.T. Grounds Department Manager, the M.I.T. Athletic Department and M.I.T. Planning Office.

11. **Outdoor Basketball Courts, Goals, and Nets:** Review with the M.I.T. Grounds Department Manager, the M.I.T. Athletic Department and M.I.T. Planning Office.

12. **Site Retaining Walls:** Engineer site retaining walls with wide stable bases to resist overturning. Dampproof earth side of retaining walls to prevent face stains. Provide drainage fill on earth side of retaining wall and provide 2" diameter weeps to relieve water pressure behind wall. Comply with Massachusetts Department of Public Works standard details where possible. All walls over 5' in height must be designed by a registered structural engineer and include the engineer's stamp.

13. Raised Planting Areas: Where an above-grade, raised planting area is provided, and where the raised area is unprotected from weather, the interior of the planter should be provided with a waterproofing membrane that will prohibit leaching of salts and soluable chemicals through the wall of the planter. The waterproofing membrane should also resist the absorption of moisture into the planter wall, as well. In addition, the interior of the planter must be insulated with a minimum two layers of flexible polystyrene insulation installed in 1 inch thinknesses. The insulation should be installed against the concrete walls over the waterproofing with a soil separator placed over the insulation, overlapped a minimum of 6". The insulation should stop 4" below the top of the soil. The planting soil should be placed in the planter to press the insulation along wall. The insulation material will act as a cushion or expansion joint between soil and planter and prevent the soil closest to the planter wall from drying out and shrinking which tends to happen when soil comes in direct contact with a concrete wall.

14. **Smoking Area Outside Buildings:** Review with the M.I.T. Grounds Department Manager and M.I.T. Safety Office. Do not locate outside smoking areas near building air intakes nor near flammable or combustible storage areas or hazards. Provide sand filled non-combustible ash and butt containers at building entrances and at outdoor smoking areas. Ash and butt containers should be located under cover or be designed to keep rain and snow from filling the sand tray. Shelter containers wherever possible.

15. **Hose Spigots:** Provide freeze-proof hose spigots spaced so that all parts of site can be reached with 100 feet of garden hose. Water shall be turned on only with “Zurn”.

16. **Site Signage:** See Section 10440 - Signs and Graphics.

17. **Bollards:** Locate bollards where approved by M.I.T. Planning Office and M.I.T. Grounds Department Manager. In general, protect building corners and walls near loading docks and drives, protect dumpster enclosures, and protect other construction from vehicular damage with steel, cast iron, concrete, or stone bollards engineered to provide at least 7,000 pound impact resistance without significant damage. Provide bollards which do not need painting or regular maintenance to the greatest extent possible. Bollards are also addressed in Section 05500.

    A. Break-Away Feature: Provide break-away or readily removable bollards for all bollards used in fire lanes.

END OF SECTION

1 GENERAL REQUIREMENTS - IRRIGATION

1.01 Scope of Work

A. **WORK INCLUDED:** The Landscaping Contractor for the MIT building or facility construction or renovation project shall furnish all labor, materials, transportation, equipment, accessories and services necessary for the installation of the irrigation control system and field devices necessary for a complete operable system including local control and remote supervisory control. The complete irrigation system shall be tested and all features demonstrated to the Owner that they are in full compliance with this specification.
ALL SHOP DRAWINGS, EQUIPMENT CONFIGURATION SHEETS AND INSTALLATION DRAWINGS SHALL BE APPROVED BY THE MIT GROUNDS GROUP. ALL PLUMBING SHALL BE APPROVED BY THE PLUMBING ENGINEER.

B. **SYSTEM GENERAL REQUIREMENTS:** The Irrigation Control System shall be a Rain Bird Maxicom^{2TM} Water Management System (Contact Rain Bird: http://www.rainbird.com). The new installation shall communicate and interface with the existing "head-end" Central Controller and Software. The existing configuration shall be upgraded and modified to add the specified functions of irrigation control that are a part of the Landscaping project.

1) **Central Controller and Software** interfaces with an existing **Weather Station** that continuously monitors rain fall, wind direction, wind speed, solar radiation, relative humidity, and temperature. The weather station data is used to calculate the evapotranspiration (ET) value. This value is, in turn, used to adjust the watering time (up or down) for every scheduled sprinkler in the entire system (existing and new). The head-end system also includes other software called Flo-Manager, Flo-Watch and Cycle+Soak.

2) **Flo-Manger** allows operation of the entire campus system within the hydraulic capacity of the water supplies.

3) **Flo-Watch** determines if there is an excessive high flow of water in any major system branch where there is a flow sensor. Upon detection of high flow rate a report is generated and a master valve is shut-off to prevent a flooded area.

4) **Cycle + Soak** is used in poor drainage areas, sloped areas or in heavy soil condition areas. It uses a short cycles to prevent surface water run-off.

5) **Cluster Control Units (CCU)** are located in locations throughout the campus. CCU's communicate with the head-end Central Controller using analog telephone lines. The CCU receives commands from the head-end such as zone station time adjustments. The CCU's, in turn, communicate with Satellite Controllers over hardwired cable. CCU's also can be directly connected to field devices such as flow sensors and pump motor control centers.

6) **Satellite Controllers** are directly connected to irrigation valves**.** Local control features are provided at the Satellite Controllers to manually override and testing of each irrigation station zone valve.

C. **EQUIPMENT AND SERVICES BY CONTRACTOR:** Equipment and services shall include but not necessarily be limited to the following:

1) Cluster Control Units completely installed, wired and tested.
2) Satellite Controllers completely installed, wired and tested.
3) Flow Meters completely installed, wired and tested.
4) Irrigation Master Valves completely installed, wired and tested.
5) Irrigation Zone Valves completely installed, wired and tested.
6) Control interface, wiring and conduit to irrigation booster pump MCCs.
7) Configuration of head-end Central Controller adding new irrigation system add-on*.
8) Configuration and testing of the CCUs*.
9) Configuration and testing of the Satellite Controllers*.
10) Testing of communications between the Central Controller and the CCUs.
11) Testing of communications between the CCUs and the Satellite Controllers.
12) Testing and commissioning of all irrigation zones.
13) NEMA 4X enclosures with hasp and padlock assembly to house all CCU's and Satellite Controllers and associated electrical equipment installed outdoors.
14) NEMA 4 enclosures with hasp and padlock assembly to house all CCU's and Satellite Controllers and associated electrical equipment installed indoors.
15) Miscellaneous devices required for a complete and working installation including lightning protection equipment, surge protection equipment, relays, decoders, modems, disconnects, terminal blocks, fuses, wire trough, cable, line and communication testing equipment.
16) Conduit and signal wiring from flow sensors, irrigation valves and other field devices to Satellite Controllers and CCUs.
17) Conduit and communications wiring for between Satellite Controllers and CCU's and phone lines.
18) Conduit and 120 volt ac power wiring between Owner's load control centers (lighting panels) and Satellite Controllers, CCUs and any other devices supplied that require power.
19) Electrical installation material and grounding in accordance with the manufacturers requirements and the National Electric Code.
20) Mechanical installation in accordance with Massachusetts Plumbing Code.
21) Shop drawings and submittals.

*Obtain the services of the manufacturers representative for these requirements.

D. RELATED WORK SPECIFIED ELSEWARE

1) Electrical Work – Division 16
2) Mechanical Work- Division 15

1.02 Work by Others

A. The following work will be performed by Others:

1) Approval of locations for all panels.
2) Shop drawing approval.
3) Witnessing of testing performed by the Contractor.
4) Power at 120 volts ac $\pm$ 10%, 60 Hz $\pm$ 5% at power distribution panel breaker.
5) Analog telephone lines installed by the MIT Telecom Group.

1.03 Removal Work

The MIT Grounds Group shall be notified of all removal work required for installation of the irrigation control system. The Contractor shall obtain approval prior to removal of existing equipment. All removed equipment shall be handed over to the Grounds Group unless it is designated for disposal. **MIT approved procedures shall be followed for Asbestos removal.**

1.04 Insulation

Upon completion of work all exposed pipe shall be covered with MIT standard insulation materials.

1.05 Materials and Equipment

Equipment and materials shall be delivered to the site and stored in original sealed containers. **The manufacturers listed in these specifications have been pre-selected to work with the design criteria for the irrigation control system. No substitutions will be accepted.**

1.06 Submittals

A set of equipment shop drawing data including but not limited to the following, shall be submitted to the Grounds Group for approval:

1. Shop drawings
2. Manufacture's model and catalog data and equipment cuts.
3. System architecture diagram
4. Communications riser diagram and telephone line specifications.
5. Enclosure/panel interior equipment arrangement drawings
6. Enclosure/panel internal wiring diagrams
7. Flow diagrams and piping drawings
8. Conduit routings and external wiring diagrams.
9. Engineering loads for irrigation water and electricity.

1.07 As-Built Record Documents/Drawings

Upon completion of work, the Landscaping contractor shall furnish to the MIT Grounds Group the following:

1. Record drawings in AutoCAD format showing
   - Locations of CCUs and Satellite Controllers
   - Piping drawings
   - Conduit routings , conduit size, number of cables and type of cable run in conduit.
   - Wiring diagrams showing external wiring between irrigation valves, flow sensors and other devices and CCUs and Satellite Controllers
2. Manufacture's model and catalog data and equipment cuts
3. Configuration sheets for irrigation control system components
4. Calibration certificates
5. Guarantee and warranty information
6. Manufacturer's Operation Manuals
7. Certified Test Reports

2 IRRIGATION DISTRIBUTION REQUIREMENTS

2.01 General

A. FLOW MEASUREMENT

Metering shall be provided to measure consumption of the main irrigation water use for each application (building or area). Irrigation main water meters shall be of the Spectrum Single Jet series, manufactured by Metron-Farnier. Meters larger than 2 inches in size shall be installed with an inlet strainer. Test Ports shall be provided in installations of meters that are 4 inches or larger. All meters shall display readings in Cubic Feet units. The meter shall be equipped with a transmitter assembly to provide an analog signal representing flow rate in gpm and a pulse signal that shall be wired back to the CCU. The pulse signal shall be compatible with the CCU and Satellite Controller signal specifications.

B. LOCATION OF METER

All meters shall be installed within the building, free from exposure to freezing. The meter shall to be accessible for ease of reading.

C. STRAINERS & TEST PORT

All meters shall be provided with Metron-Farnier strainers upstream of the meter. Test ports shall be provided downstream of the meter on installations of meters 4” and larger. The test port shall be equipped with a full port ball valve and a 2 _” M hose tread test port outlet, located so as to allow the connection of a fire hose.

D. MASTER IRRIGATION VALVE

Each building or area shall have a master irrigation valve that is used to prevent excessive irrigation water flow due to a line break or malfunction of the Satellite Controller. The valve shall fail closed upon loss of electrical power. The master valve shall operate with 24 volts ac. An isolation relay shall be installed in the panel enclosure for each Controller that operates the master valve. The master valve power supply shall be from a 120 volt ac/24 volt ac transformer fused on both sides. The transformer shall be installed in the Controller enclosure. The master valve body and port shall be sized to so that it does not restrict irrigation flow for the building or area. The master valve shall be closed by the irrigation control system upon detection of excessive flow rate. The valve shall be a bronze body with flanged ends or threaded ends rated at 150 lbs WOG and approved by the Massachusetts plumbing code.

E. MASTER VALVE INSTALLATION

The master valve shall be installed within the building, free from exposure to freezing. The contractor shall provide unions at the inlet and outlet of the master valve for threaded end valves. The valve electrical enclosure shall be NEMA 4. Manual shutoff ball valves shall be furnished upstream and downstream of the master valve. The shutoff valves shall be a bronze body with flanged ends or threaded ends rated at 150 lbs WOG and approved by the Massachusetts plumbing code.

F. BOOSTER PUMP APPLICATIONS

If the building or area requires a booster pump due to low supply pressure, the irrigation control system shall provide automatic operation of the booster pump motor starter. The booster pump MCC (motor starter) shall be provided with a hand-off-auto control switch. The Landscaping contractor shall wire the auto position to the associated Satellite Controller or CCU to start or stop the booster pump when there is a demand for irrigation water. Anytime the master valve is closed, the booster pump shall be stopped. The booster pump shall be started upon demand for irrigation. If adequate flow is not detected by the flow meter 60 seconds after the pump is started, the pump shall be stopped and a low flow failure alarm shall be initiated to the Central Controller head-end. The booster pump shall be stopped whenever there is no flow demand. The irrigation control system shall include an “ice cube” isolation relay with dry contacts rated at 10 amps to interface with the MCC 120 volt ac pilot circuit. The relay shall be an Allen-Bradley 700 HA series with DPDT contacts or Owner approved equal. The relay shall be located in the CCU or Satellite Controller enclosure.

G. IRRIGATION STATION ZONE VALVES

Irrigation station zone valves shall be installed for each grouping of sprinkler heads. Irrigation station zone valves shall fail closed on loss of power. The zone valves shall be wired back to the Satellite Controller. Irrigation valves located underground shall be installed in a protective box with access at the ground surface.

All electrical splices shall be accomplished with waterproof connectors.

3 CCU and SATELLITE CONTROLLER PANEL ENCLOSURES

3.01 General

A. REQUIREMENTS

Enclosures shall be provided to house the Satellite Controllers and CCUs and miscellaneous devices. The Landscaping Contractor may elect to furnish a common enclosure for both Satellite Controllers and CCUs if there is adequate space. The enclosure shall be wall mounted using galvanized steel Unistrut or equal bracing. The enclosure shall be sized to contain the CCU, Satellite Controller, modems, surge suppressors, transformers, relays, terminal blocks, fuses, wire trough, special cables, etc. with 6 inches space between equipment and the exterior enclosure surface. Each enclosure shall be provided with a full steel back panel for mounting all equipment within the enclosure. Enclosures shall be rated NEMA 4 steel for indoor installation and rated NEMA 4X fiberglass for outdoor installation. Enclosures shall be Hoffman or approved equal. The enclosure front door shall be hinged with a 3-point latch mechanism. A hasp hinge for a padlock shall be provided to secure the enclosure. MIT Grounds Group will provide padlocks.

B. POWER DISTRIBUTION and WIRING

Incoming 120 volt ac power shall be wired to a power terminal block for L1, L2, and Ground. L1 power shall be distributed to fuse disconnects with blown fuse indicators (Allen-Bradley 1492-H series or approved equal) for each user. Install an Intermatic AG2401 or approved equal surge suppressor for the incoming ac power line. In addition, all other power supplies at 24 volts ac and 24 volts dc shall include fused disconnects. 120 volt ac wiring shall be L1-Black, L2-White, Ground-Green. Single conductor wiring within panels shall be stranded copper type MTW, with wire gauge sized for the ampacity in accordance with National Electric Code. 24 volt ac wiring shall be red. Dc wiring shall be blue (positive) and blue with a white stripe (negative). Analog signal cable shall be stranded, 20 gauge minimum, shielded twisted pairs with continuous foil shield and copper drain wire. Wire and cable shall be labeled with permanent wire markers as shown on the shop drawings. Wires shall be run in covered wire trough (Panduit or equal) within the enclosure. Wire trough shall be no more than 50% full after the irrigation system is completely installed. Terminal blocks shall be furnished for all field wiring for irrigation valves, communications, and sensors. Terminal blocks for each voltage level and signal type shall be separated. Terminal blocks shall be rated for the maximum load ampacity. Terminal blocks shall be uniquely labeled and each terminal shall be labeled in accordance with the shop drawings. Use “finger safe” type terminal blocks similar to Allen-Bradley W series. At least 10% spare terminals and fuse disconnects shall be provided after system is completely installed.

C. LOCATION OF ENCLOSURE

The enclosure location shall be approved by the MIT Grounds Group prior to installation. Enclosures shall be located indoors wherever practical. Enclosure shall be wall mounted with adequate door swing. Do not locate panels in any manner to violate the NEC requirements. The height of the panel shall be approximately 4 foot 6 inches to the centerline of the panel above the finished floor. Outdoor CCU and Satellite Controllers may be installed in NEMA 4X stainless steel pedestal enclosures if indoor installation is not possible.

D. CONDUIT ENTRANCE

Conduits shall enter through the bottom of the enclosure whenever practical. Conduit entrance shall be weatherproof. A plastic bushing shall be provided at each conduit entrance. Conduits and wiring shall be separated according to voltage level and type. Conduits and wiring shall be run separately for 120 volts ac, 24 volts ac, and 24 volts dc.

4 CLUSTER CONTROL UNITS (CCU)

4.01 General

A. Furnish Rain Bird Maxicom^2 Cluster Control Units Model CCU-6 or CCU-28 as required for the size of the Landscaping project building or area. A CCU-6 will serve up to 6 Satellite Controllers. A CCU-28 will serve up to 28 Satellite Controllers.

B. The CCU shall be attached to the back panel of the NEMA enclosure as specified hereinbefore.

C. Installation and wiring of the CCU shall be in accordance with the vendor's recommendations. Provide #6 AWG copper ground in accordance with vendor recommendations.

5 SATELLITE CONTROLLERS

5.01 General

A. Furnish Rain Bird Maxicom^2 ESP SAT Satellite Controllers Model ESP-XXSAT-2W as required for the size of the Landscaping project building or area. The XX identifies the number of stations (irrigation zone valves). They come in 12, 16, 24, 32 and 40 station models.

B. The Satellite Controller shall be attached to the back panel of the NEMA enclosure as specified hereinbefore.

C. Installation and wiring of the Satellite Controller shall be in accordance with the vendor's recommendations. Provide #6 AWG copper ground in accordance with vendor recommendations.

6 COMMUNICATIONS EQUIPMENT

6.01 General

A. The existing communications uses analog cellular phone communications between the CCUs, weather station and the Central Controller. New installations shall be by use analog telephone lines and telephone modems.

B. The Landscaping Contractor shall provide a riser diagram showing communications interconnections and the locations of all telephone jacks to be installed for analog telephone communications. The drawings shall include all telephone line specifications to enable MIT Telecom to install the lines.

C. Telephone modems shall be installed in the CCU enclosures and at the central controller.

D. Provide a hard wired communications interface between the CCUs and the Sateliite Controllers. Use Rain Bird recommended PE-39/54/89 wire. Install a Rain Bird Maxi Surge Pipe (MSP-1) on both ends of the communications path.

7 CONFIGURATION AND PROGRAMMING

7.01 General

The Landscaping Contractor shall obtain the services of an authorized Rain Bird representative to perform the configuration and programming of the irrigation control system. This shall include the Central Controller, CCUs and Satellite Controllers.

8 WIRING REQUIREMENTS

8.01 General

A. FLOW METER WIRING

Irrigation water flow meters shall be wired from the meters to CCUs and Satellite Controllers using stranded, 18 gauge minimum, shielded twisted pair with continuous foil shield and copper drain wire. shielded twisted pair cables (Beldon 8760 or equal) run indoors in EMT conduit with compression fittings throughout and outdoors in PVC conduit. The shield drain wire shall be grounded at the enclosure and taped back and floated at the meter end. Flexible steel conduit shall be used within 3 feet of the field located meter in mechanical rooms. Four (4) inch square pull boxes are located at junction points and at least every 50 feet of conduit for tie-in accessibility. **Do not run flow meter signal wiring in the same conduit with 120 volt ac or 24 volt ac wiring**. *The covers of the boxes shall be painted blue as a designation for the irrigation circuits.*

B. MASTER VALVE WIRING
Master valves shall be wired from the meters to CCUs and Satellite Controllers using stranded single conductor 14 gauge minimum THHN red wire run in EMT conduit with compression fittings throughout and outdoors in PVC conduit . Flexible steel conduit shall be used within 3 feet of the field located valve in mechanical rooms. Four (4) inch square pull boxes are located at junction points and at least every 50 feet of conduit for tie-in accessibility. *The covers of the boxes shall be painted blue as a designation for the irrigation circuits.*

C. IRRIGATION ZONE VALVE WIRING
Install type PE (polyethylene) insulated wire between the irrigation zone valves and the Satellite Controller enclosure. Wire size and installation shall be in accordance with Rain Bird recommendations. Run wire in PVC conduit in completely sealed watertight installation throughout. Underground wire connections shall be accomplished using sealed splices. Connectors shall be3M DBY/DBR direct bury connectors or Engineer approved equal.

D. COMMUNICATIONS WIRING
Provide communications cables in accordance with Rain Bird Maxicom^{2TM} requirements and recommendations. Run communications wiring and cables indoors in EMT conduit with compression fittings throughout and outdoors in PVC conduit.

E. POWER WIRING
There shall be at least one power feed to each enclosure. The power shall originate from a load control center (lighting panel). Use a spare 20 ampere breaker when available. If there are no available 20 ampere breakers provide a 20 A breaker to match the existing breakers. Use single conductor 12 gauge minimum THHN with 600 volt insulation color coded L1-Black, L2-White, Ground-Green run indoors in EMT conduit with compression fittings throughout and outdoors in rigid conduit with weatherproof treaded fittings.

F. GROUNDING
Install grounding rods and bare copper ground wired to the control panel in accordance with the manufacturer's recommendations.

8.02 Products
A. ELECTRICAL METALLIC TUBING (EMT) CONDUIT
Galvanized EMT hot-dip galvanized outside, enameled finish inside.

B. ELECTRICAL PVC CONDUIT
PVC conduit shall be UL listed for the intended service, minimum size _ inch.

C. RIGID CONDUIT
Galvanized Steel Rigid Conduit: UL 6, hot-dip galvanized, threaded type. Each length shall be furnished with one standard threaded coupling.

D. LIQUID-TIGHT FLEXIBLE CONDUIT
A. Liquid-Tight Flexible Conduit: continuous lengths of wound and interlocked galvanized steel over which is extruded a polyvinylchloride covering.

E. CONDUIT FITTINGS

1. EMT

Fittings : Rain-tight and concrete tight compression type, made of steel with nylon-insulated throat; Gedney Company #7075 W-IT series and 6075W series. Intender type couplings shall not be used.

2. Liquid-Tight Flexible Conduit

Fittings for Liquid-Tight Flexible Conduit: Compression type with a seal to provide a watertight connection with the conduit. Use with locknut type sealing fitting having O-rings or other suitable sealing method to provide a watertight fitting in outdoor or wet areas.

Acceptable Manufacturers: Oz/Gedney, RACO or Thomas and Betts.

3. Rigid Conduit

Metal Fittings and Outlet Boxes; UL 514A and UL 514B. Fittings and outlet boxes for use with steel conduit, rigid or flexible shall be cast-metal with gasketed enclosures.

8.03 INSTALLATION

A. CONDUIT INSTALLATION

1. Exposed conduits shall be run as nearly as possible, parallel or perpendicular to walls, structural members, or intersections of vertical planes and floors. In general, they shall be run with a slight pitch and in such a manner that condensate traps will be avoided.

2. Conduits shall be installed in the straightest practical runs with a maximum pull between points as specified. Maximum pull shall not exceed 50 feet. Placement of boxes shall be installed as shown on the drawings. Install pulling fittings and boxes to fulfill this requirement whether shown or not.

a.

Total Degree Bends	Maximum Pull
0 degrees	50 feet
90 degrees	50 feet
180 degrees	50 feet
270 degrees	50 feet

b. Conduit outlet bodies may be used as pulling points in raceways containing wires of No. 6 AWG and less.

c.Pulling sleeves shall be used as pulling points in raceways containing wires of No. 4 AWG and larger.

d. Pull boxes may be used to fulfill the above requirements when sized in accordance with NEC.

e. At conduit junctions, where multiple conduits meet, a minimum 4” x 4” juction/pull box shall be used in lieu of conduit tee’s, elbows, or other fittings.

f. A minimum 4” x 4” juction/pull box shall be installed every 50 feet of conduit where there is no other junction/ pull box.

B. POWER CABLE

1. Multi-conductor cable for use as 125VDC, 120VAC and 480VAC power supplies shall be rated 600 volt, 90°C, tray cable type TC, stranded copper, flame-retardant PVC insulated, with overall flame retardant PVC jacket. Conductors shall be 12 AWG for 20 A circuits or 14 AWG for 15 A circuits.

2. Multi-pair cable for controls shall be rated 600 volt, 90°C, tray cable type TC, stranded copper, flame-retardant PVC insulated, with flame retardant PVC jacket. Conductors shall be 12 AWG for 20

A circuits or 14 AWG for 15 A circuits.

3. Single conductors installed in conduits for power and control circuits shall be rated 600 volts, 90°C, stranded copper, NEC type THHN or THWN with flame retardant insulation. Conductors shall be 12 AWG for 20 A circuits or 14 AWG for 15 A circuits.

C. CONDUCTOR COLOR CODING

1. Conductors No. 8 AWG and smaller shall have continuous color outer coverings, or color-coded plastic tapes at termination.

2. Conductors No. 6 AWG and larger shall be color-coded using colored plastic tapes at each termination.

3. Control Cable: Color-coded in accordance with NEMA Table K-2 or identified by numbers imprinted into the insulation.

4. For 120 volt, single phase wire systems

Hot or L1	Black
Neutral or L2	White
Ground	Green

D. INSTRUMENTATION AND SIGNAL WIRE AND CABLE

1. Single pair instrumentation cable shall be twisted pair or triad for RTD's, 18AWG, stranded copper, flame-retardant PVC insulated with aluminum/mylar tape shield and copper drain wire with overall flame retardant PVC jacket. Rated 300 volts, 90°C.

2. Multiple pair instrumentation cable for digital (discrete signals) and analog shall consist of individual 20 AWG, twisted pairs as specified above with an overall shield and copper drain wire and flame retardant PVC jacket. Rated 300 volts, 90°C

E. OTHER INSTRUMENTATION, COMMUNICATIONS AND SIGNAL WIRE AND CABLE

Other instrumentation and signal wire and cable shall be as specified in other sections, as recommended by the equipment manufacturer and as shown on the drawings.

F. WIRE MARKERS

Wire Markers: Plastic; Brady, Omni-Grip, slip-on type or T&B machine printed labels.

G. FIRESTOPPING

Firestopping material shall be used when there is a penetration through existing walls. Firestopping materials shall be products manufactured by Electrical Products Division/3M, St. Paul, MN 55114 or equal.

1. Firestopping materials/constructions shall constitute one or more of the following products:

   -3M Brand Caulk CP-25
   -3M Brand Putt 303
   -3M Brand Wrap/Strip FS-195

-3M Brand Composite Sheet CS-195
-3M Brand Penetrating Sealing Systems 7900 Series
-Those products compatible with the above materials as certified by 3M in their published data

2. Firestopping material shall be asbestos-free and capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of ASTM E 814, and UL 1479.

3. Materials shall be suitable for the firestopping of penetrations made by steel, glass, plastic and insulated pipe.

4. On insulated pipe, the fire-rating classification must not require removal of the insulation.

5. The rating of the firestops shall be not less than the rating of the time-rated floor or wall assembly.

6. Preparation: Clean surfaces to be in contact with firestopping materials of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting or the required fire resistance.

7. Installation:
   a. Install firestopping materials in accordance with manufacturer's instructions.
   b. Seal all holes or voids made by penetrations to ensure an effective smoke barrier.

   c. Unless protected from possible loading or traffic, install firestopping materials in floors having void openings of (4) four inches or more to support the same floor load requirements.

9 TESTING & COMMISSIONING

The Landscaping Contractor shall test, start-up and commission the irrigation control system. All interlocks and features of the system shall be tested and witnessed by the Owner's representative. This demonstration test will require the services of a qualified Rain Bird Maxicom^2 representative. Failure of any tested item shall be noted, corrected by the Landscaping Contractor, then re-tested. Testing shall include but not necessarily be limited to the following:

A. Test each irrigation zone valve functions properly from the Satellite Controller.
B. Test communications between the CCUs and the Satellite Controllers.
C. Test communications between the Central Controller and the CCUs.
D. Test that the CCU modifies the Satellite Controller station time in accordance with the Weather Station ET value.
E. Test that Flo-Watch closes the master valve by simulation of high flow.
F. Test that the booster pump (if applicable) starts and stops in automatic with flow demand.
G. Test that the booster pump (if applicable) stops if low flow is detected after the start time delay expires.
H. Test the flow meter signal is accurate by comparison against the cubic feet totalizer.
I. Test all alarms are reported to the Central Controller.
J. Review that all Central Controller Displays accurately reflect the Landscaping project addition.
K. Commission each controller. Set all configuration constants and adjust each station irrigation time based on the site conditions.

10 WARRANTY

The Landscaping Contractor shall provide a warranty for all equipment and labor for a period of 12 months following successful completion of all tests and acceptance of the irrigation control system by the Owner. All equipment repairs and/or equipment replacement and associated labor and expenses shall be borne by the Landscaping Contractor during the warranty period. The Landscaping contractor shall also be responsible to evacuate the irrigation system of water prior to the winter season during the warranty period. Any damaged equipment due to freezing at the start of the next irrigation season shall be replaced by the Landscaping contractor even if the warranty period has expired.

DIVISION 3 - Concrete

Table of Contents

SECTION 03300 – FIELD CONCRETE

PART 1 - GENERAL

1.1 Description of Work

A. This section of the specifications covers concrete and all related items necessary to place and finish the concrete work.

B. Concrete thrust and anchor blocks to be provided at fittings required by the Engineer shall be installed in accordance with the details shown on the Drawings and as specified in this section.

1.2 Standards

A. ACI Standards. The following Standards of the American Concrete Institute form a part of these Specifications and indicate the minimum standards required.

1. ACI 211.1 Recommended Practice for Selecting Proportions for Normal Weight Concrete.

2. ACI 214 Recommended Practice for Evaluation of Compression Test Results of Field Concrete.

3. ACI 304 Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete, including placing concrete by pumping methods.

4. ACI 305R Recommended Practice for Hot Weather Concreting.

5. ACI 306R Recommended Practice for Cold Weather Concreting.

6. ACI 308 Recommended Practice for Curing Concrete.

7. ACI 318 Building Code Requirements for Reinforced Concrete.

B. ASTM Standards. The following Standards of the American Society for Testing and Materials form a part of these Specifications. Unless otherwise specified, materials and methods of test shall conform to ASTM Standards.

1. A615 Deformed and Plain Billet-Steel Bars doe Concrete Reinforcement.

2. C 33 Concrete Aggregates.

3. C 94 Ready-Mixed Concrete.

4. C 143 Slump of Portland Cement Concrete.

5. C 150 Portland Cement.

6. C 260 Air-Entraining Admixtures for Concrete.

PART 2 - PRODUCTS

2.1 Concrete

A. All concrete, reinforced or non-reinforced shall have a 28-day compressive strength of 3000 psi unless otherwise noted on the design drawings. A minimum of 5.5 sacks of cement per cubic yard and a maximum water cement ration of 6.9 gallons per sack shall be used.

B. Concrete shall conform to ASTM C 94. The Contractor shall be responsible for the design of the concrete mixtures. Slump shall be a maximum of 4-inches and a minimum of 2-inches, determined in accordance with ASTM C 143.

C. Admixtures shall be as specified in subsection 2.05. No additional admixtures shall be used unless approved by the Engineer.

D. No additional water, except for the amount indicated by the design mix, shall be added to the concrete without the prior permission of the Engineer.

2.3 Reinforcing

A. Reinforcing as shown on the plans or as directed by the Engineer, shall conform to ACI 318 and ASTM A 615 and shall be detailed in accordance with ACI SP-66. All steel reinforcing bars shall be grade 60.

2.3 Cement

A. The cement shall be an approved brand of American manufactured Portland Cement, Type II conforming to the applicable requirements of ASTM C 150.

2.4 Aggregates

A. Except as otherwise noted, aggregate shall conform to the requirements of ASTM C 33.

B. Maximum size aggregate shall be _-inch.

2.5 Admixtures

A. All concrete (unless otherwise directed) shall contain as air entraining agent. Air entrained concrete shall have air content by volume of 4 to 8 percent for _-inch aggregate.

B. Air-entraining admixtures shall conform to ASTM Standard C 260. They shall be “Darex AEA”, “Vinsol NVX”, “Airecon”, “Sika AER”, or approved equal.

C. Chemical admixtures to act as water-reducing agents, retarders, or accelerators, when required or approved, shall conform to ASTM Standard C 494. Calcium chloride shall not be used as an admixture.

2.6 Water

A. Water for concrete shall be potable, free of deleterious amount of oil, acid, alkali, organic matter and other deleterious substances.

PART 3 - EXECUTION

3.1 Preparation

A. Before placing concrete, forms and the space to be occupied by the concrete shall be thoroughly cleaned, and reinforcing steel and embedded metal shall be free from dirt, oil, mill scale, loose rust, paint or a material which would tend to reduce the bond.

B. Earth, concrete, masonry, or other water permeable material against which concrete is to be placed shall be thoroughly saturated with water immediately before concrete is placed.

C. No concrete shall be placed until the consolidation of the ground and the arrangement and details of forms and reinforcing have been inspected and approved by the Engineer.

3.2 Thrust and Anchor Blocks

A. Minimum bearing areas for thrust blocks and dimensions of anchor blocks shall be as shown on the drawings.

B. Concrete for thrust and anchor blocks shall be placed against undisturbed earth, and wooden side forms shall be used to provide satisfactory lines and dimensions. Felt roofing paper shall be placed to protect joints. No concrete shall be placed so as to cover joints, bolts or nuts, or to interfere with the removal of the joints.

3.3 Concrete Placed During Cold Weather

A. Concrete shall not be placed on frozen ground, and no frozen material or material containing ice shall be used. Materials for concrete shall be heated when temperature is below 40 degrees F, or is expected to fall to below 40 degrees F, within 73 hours, and the concrete after placing shall be protected by covering, heat, or both.

B. All details of Contractor's handling and protecting of concrete during freezing weather shall be subject to the approval and direction of the Engineer. All procedures shall be in accordance with provisions of ACI 306.

3.4 Concrete Placing During Hot Weather

A. Concrete just placed shall be protected from the direct rays of the sun and the forms and reinforcement just prior to placing, shall be sprinkled with cold water. The Contractor shall make every effort to minimize delays which will result in excessive mixing of the concrete after arrival on the job.

B. During periods of excessively hot weather (90 degrees F or above), ingredients in the concrete shall be cooled insofar as possible and cold mixing water shall be used to maintain the temperature of the concrete at permissible levels all in accordance with the provisions of ACI 305. Any concrete with a temperature above 90 degrees F, when ready for placement, will not be acceptable, and will be rejected.

3.5 Field Quality Control

A. Concrete inspection and testing shall be performed by the Engineer or by an inspection laboratory, designated by the Engineer, engaged and paid for by the Owner. Testing equipment shall be supplied by the laboratory, and the preparation of samples and all testing shall be performed by laboratory personnel. Full assistance and cooperation, concrete for samples, and such auxiliary personnel and equipment as needed shall be provided by the Contractor.

B. At least 4 standard compression test cylinders shall be made and tested and 1 slump test performed from each day's placement of concrete. A minimum of 4 compression test cylinders shall be made and tested for each 100 cubic yards of each type and design strength of concrete placed. One cylinder shall be tested at 7 days, and two at 28 days. The fourth cylinder from each set shall be kept until the 28 day test report on the second and third cylinders in the same set has been received. If the average compressive strength of the two 28-day cylinders does not achieve the required level, the Engineer may elect to test the fourth cylinder immediately or test it after 56 days. If job experience indicates additional cylinder tests or other test area required for proper control or determination of concrete quality, such tests shall be made.

C. The Engineer shall have the right to reject concrete represented by low strength tests. Rejected concrete shall be promptly removed and replaced with concrete conforming to the specification. The decision of the Engineer as to whether substandard concrete is to be accepted or rejected shall be final.

END OF SECTION

SECTION 03345 - CONCRETE SEALING AND DUSTPROOFING

1. **Extent:** In general, bare concrete floors should be sealed and dustproofed to facilitate cleaning and maintenance.

   A. Discuss and evaluate each space with M.I.T. Building Services Operations Manager to determine if sealer/dustproofer is required and the type of sealer/dustproofer required. Special slip-resistant sealers may be needed; please review with Safety Office.

   B. Also see Section 09710 - Equipment Room Flooring.

2. **Products and Materials:** M.I.T.'s typical sealer/dustproofer in corridors and general spaces is Hillyard Inc. "Surfcoat" heavy duty clear epoxy finish. [Hillyard, Inc. 1-800-365-1555]. Where the appearance of "Surfcoat" is not acceptable to the Designer, the use of Hillyard "Hil-tex" undercoater followed by Hillyard "Super Hi-Tone" should be considered.

   A. Sealers and dustproofers for use in labs and other specific applications must be carefully selected for the traffic and exposure expected. Review the preliminary selection with M.I.T. Building Services Operations Manager.

   B. For information on sealers for skating rinks, parking decks, and other extreme applications, see Section 07570 - Traffic Topping Systems.

END OF SECTION

DIVISION 4 - Masonry

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SECTION 04200 - UNIT MASONRY

1. **Brick Veneer:** M.I.T. standards require strict compliance with Brick Institute of America recommendations and published standards. Brick veneer issues which are important and sometimes forgotten include the following:

   A. Deflection of Supporting Construction: Brick veneer is often supported by concrete masonry, light gage metal framing, concrete, structural steel, and other structural materials. The supporting construction shall be fairly stiff with deflection limited to L/720 maximum.

   B. Type of Supporting Construction: Brick veneer supported by light gage metal framing is somewhat controversial. Before selecting the brick veneer supporting construction, the Designer should discuss this issue in detail with the M.I.T. Project Manager and provide detailed comparisons of advantages and disadvantages of each system considered, and project specific information on life cycle costs of each system considered.

   C. Veneer Cavity Size: The clear space between the cavity side of the brick veneer and the nearest obstruction [sheathing, concrete masonry, or cavity insulation] shall be at least 2". This is a Brick Institute recommendation and is based on the minimum clearance to keep the cavity clean and free from excessive mortar droppings and bridges. Mortar boards should be specified for use during the installation of the masonry to keep cavity clear. Specify that the mason should not strike-off cavity side of masonry. This will reduce the potential for dropping mortar into the cavity.

   D. Veneer Ties: The brick veneer shall be designed, detailed, and tied to the supporting construction so that positive and negative wind loads are transferred to the supporting construction and not resisted by the veneer. To accomplish this requires brick veneer ties with very little "play" in both tension and compression [0.05" maximum movement allowed]. So called drip ties designed to drip moisture from their top surface are typically weaker than straight ties and should be specified in a heavier gage when used. Ties should be hot dip galvanized or stainless steel; mill galvanized is not acceptable.

   E. Flashing: Brick veneer walls cannot be properly constructed without careful attention to flashing details. Flashing details should be very large scale and axonometric if necessary to communicate the details of corners and terminations. Additional flashing Guidelines are included in Section 07600 - Flashing and Sheet Metal. Flashing should extend vertically a minimum of 12", penetrate the sheathing, extend 2" above the penetration and be secured to the back of the sheathing. If self-adhered flashing is used (e.g. "Permabarrier" by W.R. Grace), the flashing need not penetrate the sheathing. The Designer should give consideration to the standard widths of flashing when designing these details.

   F. Cavity Dampproofing: Asphalt impregnated building paper 'felt" can be used as dampproofing in exterior wall cavities. The felt is typically stapled to the face of the gypsum sheathing. The staples and any tears in the paper should be covered with sheathing tape to prevent exposure to moisture in the cavity.

   G. Weeps: Weeps allow the moisture within the cavity to drain to the exterior of the wall. They should be located at the bottom of each cavity section, i.e. window heads, relieving angles, etc., no more than 24" on center horizontally. While there are several different types of weeps, "full head" weeps offer the maximum drain area and the least possibility for clogging over time.

   H. Cavity Fill: Consider the use of pea stone in the cavity to assist drainage. Pea stone often protects the weeps from mortar spills but may also collect and retain moisture in the cavity.

I. Expansion and Control Joints: Brick veneer needs expansion joints to accommodate thermal expansion and since brick typically “grows” as it ages [it is manufactured in a kiln and starts out unusually dry; its size increases as it absorbs moisture and reaches equilibrium with the environment]. Veneer expansion joints do not inherently require a building expansion joint at the same location. Control joints are needed in masonry veneer to relieve stresses at locations such as heads of openings and changes of plane. Horizontal expansion and control joints are also needed at shelf angles and other locations.

J. Please study the Brick Institute of America recommendations regarding locations and requirements for brick expansion and control joints [See BIA Technical Notes 18, 18A, and 18B].

2. **Exterior Concrete Masonry:** Make sure you select and specify concrete masonry units which are intended for exterior use; not all concrete masonry units can be used in an exterior application.

A. Coatings and Waterproofing: Exterior concrete masonry often needs a waterproof coating which can be an elastomeric “paint” or a clear sealer.

3. **Interior Concrete Masonry:** At non-axially loadbearing concrete masonry partitions, the top of the partition must be laterally supported to prevent the wall from falling over during earthquake loads or other lateral loads. Metal clip angles on both sides of the wall are often used, but concealed anchors are also available.

4. **Mortar:** Specify mortar to comply with ASTM C270 Property Specifications. M.I.T. will typically hire an independent testing agency to take mortar samples and test for compliance. The Contractor shall pay for all failed tests and all remedial work.

5. **Match Existing:** Specifications which say “match existing” have often been a problem on past M.I.T. projects. Please find at least one specific masonry sample which you as the Designer believe is acceptable in appearance. You can often do this simply by asking local masonry suppliers to see the masonry you are trying to match and asking the suppliers to bring you two or three samples they think will match. You may also learn that no acceptable match exists; hopefully early enough so that you can do something about it.

6. **Mock-Ups:** In cases where masonry is to be installed, full size mock-ups should be included in the specifications. The mock-ups should be large enough to include the relevant aspects of all of the different conditions to be reviewed and be a minimum of 4' x 4'. If appropriate, the mock-ups should include a typical fenestration. Coordinate this requirement with the Window Section. Often it is useful to include isometric drawings of the required mock-ups for clarity.

END OF SECTION

DIVISION 5 - Metals

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SECTION 05120 - STRUCTURAL STEEL

1. **Structural steel:** Work for M.I.T. is not typically different than structural steel work for any other project. In general, comply with American Institute of Steel Construction and American Welding Society standards and recommendations.

2. **Fireproofing:** Coordinate the type of fireproofing to be used with structural steel primers. Some fireproofing materials cannot be easily or economically applied to painted surfaces and some UL fireproofing designs do not permit primed steel.

END OF SECTION

SECTION 05210 - STEEL JOISTS

1. **Steel joist:** Work for M.I.T. is not typically different than steel joist work for any other project. In general, comply with Steel Joist Institute and American Welding Society standards and recommendations.

2. **Fireproofing:** Fireproofing of joists may not be economical since providing adequate coverage over the joist members is sometimes difficult. Coordinate the type of fireproofing to be used with steel joist primers. Some fireproofing materials cannot be easily or economically applied to painted surfaces and some UL fireproofing designs do not permit primed steel.

END OF SECTION

SECTION 05300 - METAL DECKING

1. **General Decking Limitation:** For concrete on metal deck slabs, use metal decking only as formwork left in place. Do not rely on metal decking without concrete slab for any permanent structural component or as tensile reinforcing for concrete slabs.

2. **Floor Decking:** Use either painted or galvanized steel.

   A. Fireproofing: Coordinate the use of fireproofing applied to painted decking. Some fireproofing products cannot be easily and economically applied to painted surfaces.

3. **Roof Decking:** Use only galvanized steel, since roof decking may be likely to corrode because of condensation and roof leaks.

END OF SECTION

SECTION 05400 - LIGHT GAGE METAL FRAMING

1. **Light gage metal framing:** is often used to support exterior building skin systems such as face brick, synthetic and metal panel systems, and other exterior skins.

   A. This work is inherently structural in nature and must be designed and engineered by a professional structural engineer.

   B. Light gage metal framing must be engineered to support all loads including wind loads and earthquake loads, and must meet deflection constraints of the material to be supported. For face brick the maximum deflection should be L/720.

   C. All light gage metal framing shall be fabricated from galvanized steel [minimum G90] and shall be of sufficient gage and metal thickness to resist failure due to corrosion. Selecting the metal gage is a function of corrosion resistance as well as structural capacity and deflection limitation.

   D. Since brick veneer supported by light gage metal framing is somewhat controversial, the Designer should discuss this issue in detail with the M.I.T. Project Manager and provide detailed comparisons of advantages and disadvantages of alternative systems considered, and provide project specific information on life cycle costs of each system considered, if requested.

END OF SECTION

SECTION 05500 - MISCELLANEOUS METALS

1. **Miscellaneous Metals:** Typically includes items of steel and sometimes aluminum which are not specified as part of the building structure or part of ornamental metal sections. To avoid Change Orders, the scope of Miscellaneous Metal work should be carefully reviewed and itemized prior to issuing Contract Documents. The following is a checklist of some common Miscellaneous Metal items:

•Vertical ladders at elevator pits, catwalks and elsewhere. Ladders over 20 feet high require safety cages [OSHA requirement]. Ladders cannot be used for roof access; stairs must go to the roof wherever practicable.

•Tether cables for access panels and covers used on rooftop mechanical equipment. These are intended to prevent loose panels and covers from blowing off roofs when removed for equipment maintenance. This may need to be specified with the mechanical equipment in Division 15; please coordinate so that this requirement is specified.

•Ladder rungs [sometimes cast into concrete or built into masonry].

•Steel handrails and guardrails [check that both interior and exterior work is covered]. Continuous guardrails are required on roofs to provide a continuous, safe path to roof mounted equipment and to completely enclose roof mounted equipment whenever roof mounted equipment is within 20 feet of a roof edge.

•One-way gate at egress stairs to direct people to egress landing and stop egress into basement. This is sometimes used when people in a fire stair may accidentally go beyond street level into a basement looking for egress.

•Loose steel lintels for masonry work. This may include lintels fabricated from more than one steel shape or member.

•Miscellaneous shelf angles to support precast concrete, masonry, and stone. These may need an intermittent rod welded to the horizontal angle for lateral restraint.

•Miscellaneous framing and supports for skylights. This is often not shown on structural drawings, and if not covered under 05500, could become a change order.

•Loading dock edge angles. These are used to protect the edge of a concrete loading dock.

•Ceiling hung toilet partition supports and framing. These require coordination with the toilet partitions.

•Steel pipe bollards. Often needed in parking garages, at loading docks, at vehicular overhead doors, and at waste handling equipment.

•Cast iron wheel guards. These are cast iron used at the bottom jamb of overhead vehicular doors. They are not often used on new buildings.

•Elevator subsill angles. These support the finished sill and are not included in typical elevator contracts [elevator shop drawings often show the subsill angle as “by others”].

•Bearing and leveling plates. These probably should be included in structural steel and timber specification sections, but it is listed here to remind you to check to see they are covered.

•Metal stair systems. These can be concrete filled metal pans, metal plate with no concrete, and other types. They are often modular systems which are assembled quickly at the site.

•Counter support brackets. Countertops may need concealed metal brackets and angles.

•Window washing tie-backs and davit sockets. This needs to be coordinate with the window washing equipment in Division 11. This is normally needed in buildings requiring window washing from the exterior on swing stages and boson's chairs.

•Steel door frames fabricated from steel channels. These heavy-duty frames are often used at loading docks and vehicular doors.

•Stair nosings. These can be cast-in-place to protect the stair nosing from chipping and damage and to improve slip resistance. Metal stair nosings used outside can also trap water and snow melting chemicals and can sometimes cause problems.

•Metal gratings. These are used at areaways, catwalks, and mechanical platforms. Provide metal gratings at each floor level in all large shafts [but not elevator shafts] in the building. The gratings are intended to provide maintenance platforms even if there is no door or access panel into the shaft [M.I.T. may need to cut an access way into the shaft later]. The gratings are also intended to discourage "mountain" climbing within the shafts by adventurous students. The grating platforms should be engineered to support at least 40 pounds per square foot and should be assembled with bolts to permit simple removal of individual grate panels to permit access and movement of materials and equipment.

•Floor plates. These are used at catwalks, mechanical platforms and over utility trenches.

•Rough hardware. This is for custom fabricated rough hardware required for the project.

•Corner guards fabricated from rolled steel shapes. These are used in parking garages, at loading docks, and elsewhere there is heavy traffic.

•Automobile guardrails. These are often used in parking garages.

•Steel clip angles for lateral support of masonry partitions. These are to prevent non-axial loadbearing masonry partitions from falling over.

•Steel posts to support less than full height gypsum drywall partitions.

•Supports for operable partitions. These are often concealed above ceilings.

•Prefabricated concrete filled columns. This includes Lally columns.

•Elevator beams, hoisting beams, divider beams, and pit beams if not shown on structural drawings.

2. **Spiral Stairs and steeply inclined Ship's Ladders:** Do not use at M.I.T.

A. Ship's ladders may occasionally be considered for access to the roof in situations where there is no available space for stairs.

B. Do not use alternating tread stairs under any circumstances.

3. **Galvanizing and Painting:** Miscellaneous metal work should be carefully reviewed to identify all items which should be galvanized and all items which should be shop primed and shop finished. In general, all exterior ferrous metal items should be galvanized. The miscellaneous metal finishing requirements must be coordinated with the Section 09900 - Painting requirements to avoid Change Orders. Welding of galvanized metal (exterior relieving angles, etc.) will remove the galvanized coating. The Designer should note the requirement for repairing welds with a zinc coating.

END OF SECTION

DIVISION 6 - Wood and Plastics

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SECTION 06100 - ROUGH CARPENTRY

1. **Blocking:** A major portion of rough carpentry work at M.I.T. is blocking to support other work. To avoid Change Orders, the scope of blocking required should be clearly indicated. The following is a checklist of some common items which may need concealed wood blocking:

   A. Miscellaneous Metals such as handrails.
   B. Finish Carpentry and Millwork including office shelves and casework
   C. Roofing and Flashing
   D. Roof Accessories and Skylights
   E. Windows
   F. Chalkboards and Tackboards
   G. Toilet Partitions
   H. Signage and Graphics
   I. Fire Extinguishers and Cabinets
   J. Toilet Accessories, especially grab bars which require structural support.
   K. Projection Screens
   L. Casework and attached furnishings including lab bench casework
   M. Window Treatment such as blinds, shades, and drapes.
   N. Electrical such as mounting boards for telephone, fire alarm, and electrical panels.
   O. Exterior rough blocking. Materials should be pressure treated.
   P. Blocking behind ceramic tile base.

2. **Blocking for Roofing:** Make top of blocking align with top of roof insulation to prevent any sharp or abrupt change of plane which would damage the roof covering. Securely anchor roof blocking to building structure to withstand at least a 360 pound uplift force when tested at any location, to comply with the roof system manufacturer's requirements, and to comply with Factory Mutual Loss Prevention Data 1-49. The most restrictive shall govern.

   A. Preservative Treatment of Roof Blocking: Preservative treated wood blocking and nailers in contact with membrane roofing systems must be treated with wood preservatives which are approved by the roof system manufacturer. The following wood preservatives are typically prohibited: creosote, pentachlorophenal, copper napthenate, copper 8-quinolinolate, and other preservatives not approved by the roof system manufacturer. Any other blocking required on the roof must also be pressure treated.

3. **Fire-Retardant Treated Plywood:** Due to some widely published failures and problems, the use of fire-retardant treated plywood has become controversial in roofing applications. Do not use fire-retardant treated plywood on M.I.T. projects at locations where elevated temperatures can cause deterioration of the fire-retardant treated plywood. For alternate designs, provide equivalent fire-retardancy. Gypsum board placed directly under non-fire-retardant plywood may be considered, and City of Cambridge building officials must review and approved alternate schemes.

4. **Fire-Retardant Treated Wood Blocking:** The City of Cambridge requires fire-retardant treated wood blocking; intumescent paints and surface applied fire-retardant treatments are not acceptable.

END OF SECTION

SECTION 06200 - FINISH CARPENTRY

1. **Quality Standards:** The Architectural Woodwork Institute publication “Architectural Woodwork Quality Standards, Guide Specifications, and Quality Certification Program” should be used extensively when designing, detailing, and specifying finish carpentry and millwork.

   A. Quality Standard: It is not sufficient to reference a general AWI Quality Standard such as “Premium Grade”. The reference standard often includes Contractor options for each grade; the Designer/Specifier should review these options and narrow the choices by details and specifications as appropriate to the project. The reference standard also often includes lists of work which is “not included” which must be reviewed and adjusted by the Designer/Specifier.

2. **Fire-Performance:** The basic M.I.T. requirement is to comply with building codes. The Massachusetts State Building Code Table 920 gives interior finish classification requirements which will affect wood finishes such as paneling. The requirements for wood trim are given in the Code article 920.6.

   A. Fire Classifications of Wood Species: The Architectural Woodwork Institute publishes the flame spread classifications of some common species in “Architectural Woodwork Quality Standards, Guide Specifications, and Quality Certification Program”, Section 100-G-1. Untreated wood is mostly Class III or Class C. Many species can be reduced to Class I or II [Class A or B] by the use of pressure applied fire-retardant chemical treatment. The City of Cambridge will not accept intumescent paints and surface applied fire-retardant treatments [pressure fire-treated wood only].

   B. Wood Paneling: Use fire-retardant treated cores and panels, even if the thin visible wood veneer does not need to be fire-retardant treated.

3. **Casework:** Custom casework should be detailed in both elevation and section. The AWI publication “Architectural Casework - General” is a good reference and includes some typical casework details. The specifications should follow the master guideline specifications included in the AWI publication referenced above. The quality of the case materials, the thickness of each panel, and the types of connections and construction should all be clearly defined.

   A. Substrates: M.I.T. recommends the use of fiber core substrates for wood veneer applications; particle core substrates for plastic laminate substrates except in severely wet locations such as laboratories. Refer to Section 12345 for recommendations for counter tops in wet locations. Plywood substrates for laminates are not recommended.

   B. Casework Hardware: Since the AWI reference standard only requires “hardware standard with the woodworker” you must specify the casework hardware in detail to control quality. Inferior quality hinges are a common problem; specify institutional quality 5 knuckle butt hinges wherever possible. Specify high quality ball-bearing drawer slides with load capacity appropriate for the intended use. Drawer and door pulls should be barrier-free but should not protrude in a manner which suggests the pull could be used as a step [a common problem for lower drawer pulls].

   C. Casework Hardware Availability: Hardware used on casework must be readily and commonly available. Use hardware which has been available for a long time and which is expected to be available long into the future.

4. **Countertops:** Plastic laminate countertops should be constructed with “backer sheets” or “balancing sheets” on concealed surfaces to reduce warping. All parts of the core should be completely covered with laminate or thoroughly sealed against moisture to reduce problems with the core swelling and popping laminate loose; this is especially important at loose splashes.

A. Countertop Limitations: Countertops in toilet rooms at lavatories are difficult to keep dry, difficult to keep clean, and are easily damaged. If used, lavatories must be under-mounted, not self-rimming. Wall hung lavatories without countertops are preferred. A countertop opposite or near the lavatories is desirable to provide a place for books, purses, and parcels when using the lavatory. Countertops should be adequately braced and framed to support heavy and unusual loads [like people sitting or standing on the countertops]. Solid surface countertops such as Dupont Corian and Nevamar Fountainhead are acceptable.

5. Finishes: Take care specifying factory finishes for finish carpentry and millwork since many of these finishes are difficult to touch-up and re-coat on site. M.I.T. prefers woodwork to be field finished with polyurethane for interior applications or alkyd varnish for exterior applications. Oil finishes often require excessive maintenance and are not preferred. Oil finishes should definitely not be used in an exterior application.

6. Accessibility: Refer to Division 1 - Uncommon Ordinances and Requirements for accessibility requirements that are specific to casework at M.I.T.

END OF SECTION

DIVISION 7 - Thermal and Moisture Protection

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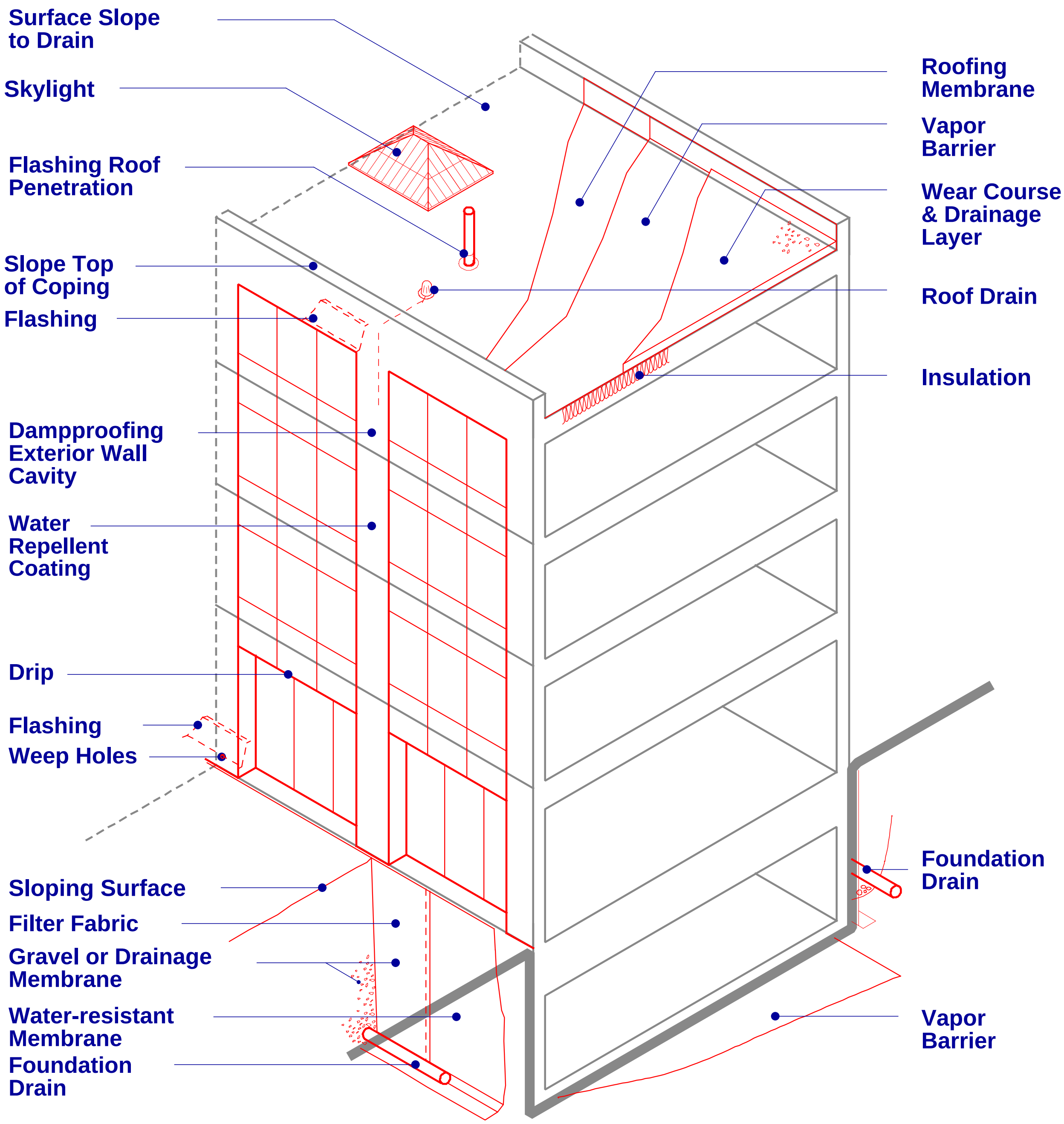
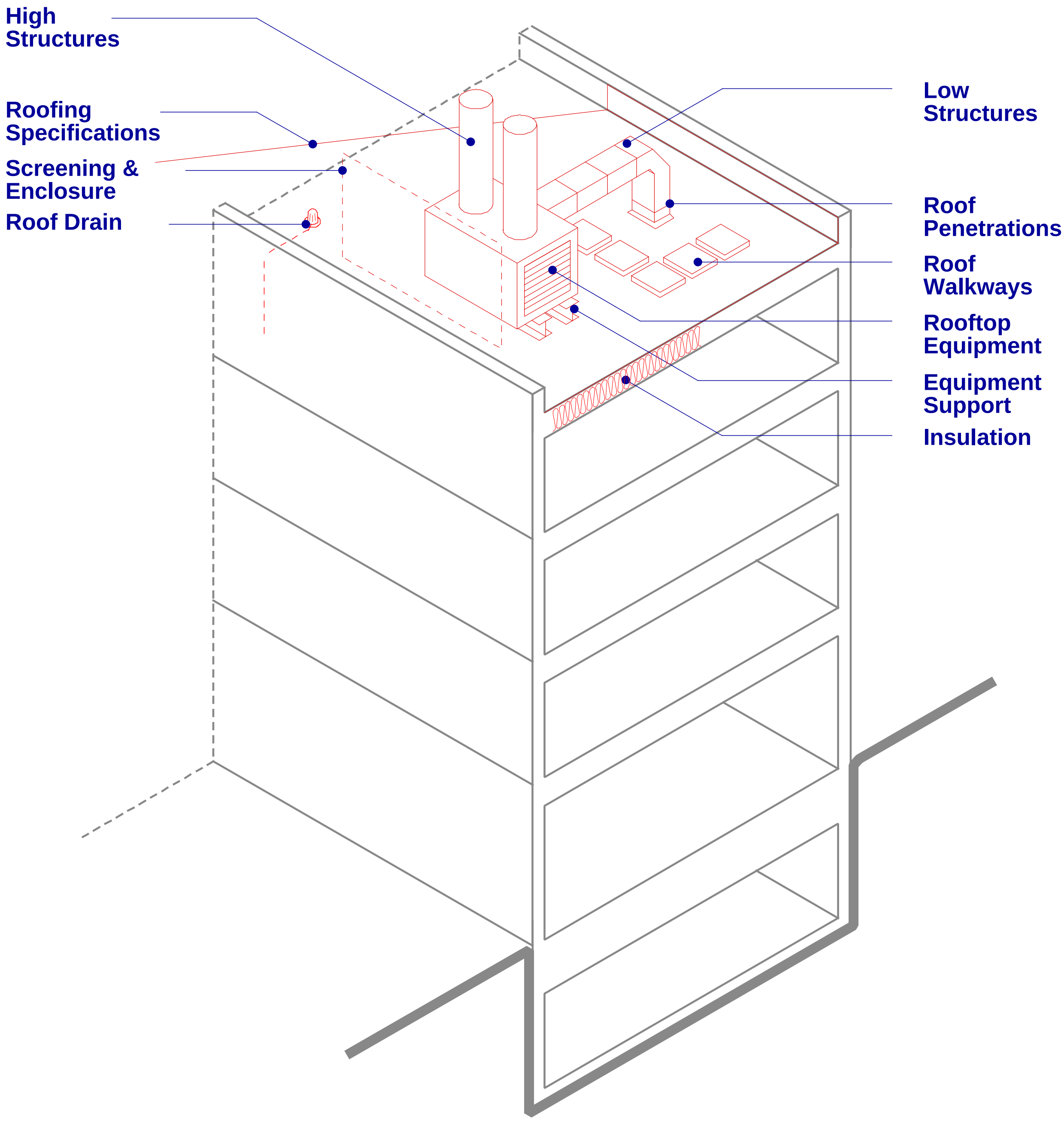
7 THERMAL & MOISTURE PROTECTION - Waterproofing & Dampproofing



7 THERMAL & MOISTURE PROTECTION - Roofing



SECTION 07100 - WATERPROOFING AND DAMPPROOFING

1. **Definitions:** Waterproofing is intended to stop the passage of large quantities of water under pressure such as standing water. Dampproofing is intended to stop water in small quantities without pressure and is often used to control dampness and water vapor. Because it is intended to do more, waterproofing is often more expensive than dampproofing. There is no reason to use waterproofing where dampproofing will do the job.

2. **Selection Data:** Sweet's catalog for General Building and Renovation, Volume 1 includes "Selection Data" and a section devoted to Waterproofing and Dampproofing. Checklists, evaluation criteria, and some references are included to help decide which materials and products to use.

   A. M.I.T. History: M.I.T. has successfully used W. R. Grace "Bituthene" waterproofing. The Designer is still responsible for appropriate waterproofing selection.

3. **Tests:** Since waterproofing is intended to stop large quantities of water under pressure and often used where water damage would be a significant problem, field tests of waterproofing after it is installed and before it is covered are highly recommended. Field tests of waterproofing are often very simple; ponding tests and water spray tests are the most common forms. Ensure that the structure can withstand the load before making ponding tests [since only a little water need be ponded, this should not be a problem].

4. **Waterproofing at Below Grade Applications:** Below grade waterproofing usually takes the form of a complete "bathtub" covering all horizontal and vertical surfaces of the structure. Since this creates a "boat" the structure may need to be designed to resist floating and the horizontal slabs may need to be designed to resist the upward hydrostatic pressure. Waterproofing the vertical and horizontal surfaces requires careful detailing of joints and intersections.

5. **Waterproofing Terraces and Above Occupied Spaces:** These are like roofs, but cannot typically get long-term roof warranties because of the traffic and unique application. The top of the waterproofing layer should slope to drain and not be expected to pond water. Elastomeric liquid applied membranes and sheet applied membranes are often used successfully. Fully adhered systems have the advantage of localizing leaks [if water can move freely under the waterproof membrane, leaks may be impossible to trace].

6. **Dampproofing at Below Grade Applications:** There are two basic types of dampproofing: solvent based "cut back" dampproofing and water-based emulsions. Solvent types can be used in lower ambient temperatures, but sometimes cannot be applied over newly installed concrete until the concrete has cured. Solvent dampproofing is better for below grade applications. Solvent based products can pollute the air and harm workers in confined spaces. Water-based emulsions can freeze and often require higher working temperatures. Emulsion dampproofing can usually be applied over concrete immediately after the forms are stripped.

7. **Dampproofing at Exterior Wall Cavities:** Emulsion dampproofing is probably best here since solvent type products can sometimes leach oils which stain other materials usually near weep holes. Asphalt impregnated building paper 'felt' can be used as dampproofing in exterior wall cavities. The felt is typically stapled to the face of the gypsum sheathing. The staples and any tears in the paper should be covered with sheathing tape to prevent exposure to moisture in the cavity.

END OF SECTION

SECTION 07175 - WATER REPELLENT COATING

1. **Water Repellent Coatings:** are often used on horizontal concrete surfaces to reduce water and salt [chloride ion] penetration.

   A. Brick: Water repellents should be avoided on brick masonry since the water repellent can effect vapor migration and possibly trap moisture causing spalling and freeze/thaw problems.

   B. Concrete Masonry: Some type of water repellent coating is often needed on single wythe exterior concrete masonry walls to make the walls watertight. An elastomeric breathable masonry paint should be also considered [see Section 09900].

2. **M.I.T. History:** M.I.T. has successfully used ProSoCo “Consolideck SX” and Huls America Inc. “Chem-Trete”. The Designer is still responsible for appropriate water repellent coating selection and specification.

3. **Tests:** Since water repellent coatings are intended to reduce damage and corrosion of reinforcing steel, tests may be appropriate for critical applications. Concrete cores can be taken prior to material application to provide a baseline record. Additional cores can be taken after material is applied. In the future if a problem occurs, cores can be taken and compared to the original cores to see if the material performed as promised and if the material manufacturer and Contractor can be held accountable. An effective warranty would also be required.

END OF SECTION

SECTION 07200 - INSULATION AND VAPOR BARRIERS

1. **General Energy Guidelines:** The following guidelines are minimum levels of performance that should be met. Building life cycle energy use analyses should be made to determine if higher energy performance is cost effective.

   A. Non-Window Above Grade Vertical Enclosures: U-value of 0.080 Btu/hr./s.f./°F. or better.

   B. Windows: This should be specified in the window section and not Section 07200.

   C. Roof Assembly: This should be specified in the roof section and not Section 07200.

2. **Foam Insulation:** Extruded polystyrene is preferred; do not use expanded polystyrene. Several compressive strengths are available for various applications. In general, foam insulation is flammable and must be protected from combustion. Foam insulation may float out of proper position in very wet areas. Extruded polystyrene insulation may act as a vapor barrier without any added facing. R-values of 5 per inch thickness are normal.

   A. CFC Blowing Agents and the Ozone Layer: Do not use or specify any foam insulation which is produced with CFC [chloroflurocarbon] blowing agents which can damage the Earth's ozone layer.

   B. Recyclability: Consider the potential for recyclability when choosing foam insulation for any application where the foam may need to be discarded in the future. Roof insulation is often discarded during re-roofing.

   C. Roof Insulation: See Section 07500 - Roofing.

3. **Semi-Rigid Glass Fiber Insulation:** Since several densities are available, each having different performance characteristics, the density should be specified. This type of insulation is often used as the core of acoustical panels and often does not need to protected from fire since it is usually Class A. This insulation is available with foil and other vapor barrier facings; these facings usually increase the flame spread and decrease fire safety. R-values of about 4 per inch thickness are normal.

4. **Batt and Blanket Glass Fiber Insulation:** This type of insulation is very commonly used where space is available. R-values of 3.04-3.15 per inch thickness are typical. Batt insulation is available with combustible vapor barrier facings; Class A facings are available. Since this material is flexible, it may sag in cavities; it should be securely held in place with barbed stick-clips or other devices.

5. **Vapor Barriers:** Vapor barriers are needed to control the movement of water vapor and to prevent condensation within exterior building assemblies. Vapor barriers may be needed in walls and roofs [roof vapor barriers should be specified in the roof spec.].

   A. Types: A variety of vapor barriers may be used including types such as polyethylene sheeting, vapor barrier facings on the insulation, and foil faced gypsum wallboard. Whichever type is used, the vapor barrier must be continuous and undamaged to function properly. Seams and penetrations for utilities are obvious critical areas.

6. **Steam Tunnels and Pipes:** Be especially careful to insulate steam tunnels and pipes beneath plants and trees. The heat interferes with the normal winter dormant cycles of the plants and trees causing damage and death. Allow for 48" minimum cover over steamline insulation to allow for adequate plant root development. Insulation must be installed on the top and sides of the steamline.

END OF SECTION

SECTION 07265 - FIREPROOFING

1. **Fireproofing:** The extent and performance of fireproofing is basically defined in building codes. Commonly, problems occur when the Designer does not clearly indicate the scope of fireproofing work, the fire-resistance ratings required, and the limits of each type of fireproofing when more than one type is used. To vaguely require the Contractor to “meet code” is inadequate and not acceptable on M.I.T. projects.

   A. UL Listings: Fireproofing should match UL tested and listed assemblies. The Contract Documents should note the UL assemblies to be matched.

2. **Fireproofing Testing:** Installed fireproofing should be tested for density, thickness, bond, and other important characteristics. Since the application technique can result in significant variation in these characteristics, and since fireproofing which is not up to specification may not perform as intended, field tests are important and should be required for most projects.

   A. Cost of Testing: M.I.T. General Conditions 8.1.1 (available from the M.I.T. Project Manager) establish that the Contractor shall provide and pay for all testing (these General conditions apply to capital projects only), unless specifically indicated otherwise in a specification section.

3. **Types of Fireproofing:** Sprayed mineral fiber, cementitious, and intumescent mastic fireproofing materials are commonly used. Fireproofing must be UL or FM approved. M.I.T. prefers to use non-fibrous fireproofing since the fibers may need to be removed or encapsulated in the future.

4. **Friability:** Some types of fireproofing especially low density, low bond strength types such as mineral fiber have problems with friability in areas of high air movement such as plenums and areas of vibrations such as steel supporting elevators or machinery. Fireproofing should be selected to mitigate and minimize these problems. Surface tamping and sealing are sometimes used to help bind the fireproofing together and to reduce friability.

5. **Mold and Mildew Inhibitors:** Some types of fireproofing provide an excellent base for mold, mildew and other unwanted growth. This can be a major problem in medical, laboratory, and research spaces. These problems should be anticipated and corrective mold and mildewcide admixtures should be specified in the original application.

6. **Exposed to View Applications:** Where fireproofing is visible, architectural finishes may be used to conceal the fireproofing or the fireproofing itself may be treated with plaster-like coatings to create acceptable exposed surfaces. In areas subject to contact and abuse, special fireproofing suitable for this exposure is required. Intumescent mastic fireproofing is often used where hard, durable, and architecturally pleasing fireproofing is needed.

END OF SECTION

SECTION 07270 - FIRESTOPPING

1. **Firestopping:** The basic M.I.T. requirement is to meet the requirements of building codes. The extent and intent of firestopping work is described in Section 919 of the Commonwealth of Massachusetts State Building Code.

   A. The type of fireproofing selected should accommodate the expected use. Some areas frequently run cables and a firestopping system which can easily accommodate this activity is preferred.

2. **Required Submittals:** Since several locations will typically need to be firestopped, several firestopping materials and systems will be used. Each of the firestopping systems to be used should match a UL or FM listed and tested firestopping assembly. The Contract Documents should require detailed submittals and information on similar UL or FM listed assemblies for each type of firestopping system used.

3. **Inspection:** M.I.T. has problems getting proper firestopping work completed before walls and concealing construction is installed. Write strict review and inspection procedures into project specifications to help ensure that firestopping work is properly done. Require Contractors to obtain approval of M.I.T.'s project representative prior to enclosing and concealing firestopping work.

4. **Odors:** Firestopping selected should be of low toxicity and produce little or no odor. Arrangements must be made to isolate and ventilate the area during the work and notify the occupants of the adjoining areas, when odors are present. Contact IHO for additional advice.

END OF SECTION

SECTION 07420 - ROOF-TOP EQUIPMENT SCREEN SYSTEMS

1. **Equipment Screens:** Screens are commonly used to partially conceal equipment located on roofs. These may be required by zoning ordinance in some instances.

2. **Wind:** The screen assembly shall be attached to the building structure to withstand at least Factory Mutual Class I-90 wind loads and wind loads prescribed by code [the most restrictive shall govern].

3. **Roof Interface:** The screen system and its supporting structure shall be designed to touch the roof in the fewest number of locations possible and designed so that roof maintenance and repair work is not obstructed. The roof flashing detail at the base of the roof screen supports should be carefully considered and should comply with the roof system manufacturer's recommended details and excellent roofing standards.

4. **Material and Finish:** The material and finish on the equipment screen should require little maintenance. Wood screens are not recommended because of flammability and maintenance issues. A finish which meets or exceeds the high performance requirements of American Architectural Manufacturers Association AAMA 605.2 is preferred.

5. **Screen Locations:** The screen system must be properly located and coordinated with the screened equipment to ensure that adequate working room and equipment access is provided, and to ensure that proper ventilation and air flow is not obstructed. The equipment manufacturer's product data sheets must be used to verify that minimum clearances are maintained and reasonable service access is provided.

END OF SECTION

SECTION 07500 - ROOFING

1. **Preferred Roofing Systems:** The M.I.T. preferred roof system is 5 ply built-up tar and gravel roof. Coal tar is preferred over asphalt because of its self-healing and low temperature flowing properties. Coal tar is a known human carcinogen and coal tar manufacturers often issue warnings and liability limitation statements with their products. The Designer must require the Contractor to submit and follow recommendations and requirements found in the Material Data Safety Sheets and manufacturers safety requirements.

   A. Single-Ply Membrane Roofing: M.I.T. has successfully used adhered and mechanically fastened EPDM, Reinforced P.V.C., and Hypalon roofing systems. Ballasted roofs are not acceptable. This method is often less expensive than 5 ply BUR.

   B. Mechanically fastened roof assemblies have the desirable advantage of reducing the quantity of combustible material in the roof assembly.

   C. Roof Assembly: U-value of 0.050 Btu/hr./s.f./°F. or better. This should be specified in the roof section and not Section 07200. Do not specify any roofing materials that contain CFC's or asbestos.

2. **Roof Penetrations:** The Designer must review the scope of work with the Manager for Building Maintenance prior to specifying the work.

   A. Capitol Projects: In certain cases, M.I.T. may elect to have the General Contractor perform all of the roofing work.

   B. Renovation Projects: Depending on the size and number of the penetrations to be made, M.I.T. may require the General Contractor to be responsible for making the necessary openings and protecting the roof and space below from weather damage. In these instances, M.I.T. will perform the actual patching of the roof. This includes flashing to objects provided by the G.C. The G.C. would provide and install all roof accessories.

3. **Roof Performance Requirements:** Roof systems should provide at least the following minimum levels of performance:

   A. Wind Uplift: Provide Factory Mutual Class I-90.

   B. External Fire Performance: Provide UL Class A.

   C. Internal Fire Performance: Provide roof ceiling assembly to comply with building codes.

4. **Warranty:** Provide minimum 10 year written warranty covering all labor and material to repair or replace roofing as needed to eliminate leakage and to meet the above performance requirements.

5. **Testing Existing Roofs Prior to Re-Roofing or Repair:** Require test cuts to inspect insulation and roof decks. Infrared scanning should be performed to check for excessive heat loss and to identify areas where insulation is not performing properly.

   A. Hazardous Waste: Many old roofing materials contain asbestos. Samples of existing roofs should be tested for the presence of asbestos before roof removal. Disposal of existing roofing is often treated as hazardous and requires special removal, transportation and disposal procedures which should be specified. For these reasons, leaving an existing roof in-place and re-roofing over the top is sometimes advantageous.

6. **Re-Roofing Procedures:** Never re-roof over existing wet insulation and damaged roof decking. Remove existing ballast and gravel before re-roofing. Make special efforts to control dust. Even if new insulation is not required, provide at least a thin isolation layer of insulation between old and new roof assemblies. Require the roof manufacturer's representative to inspect and accept in writing all existing roof substrates prior to installation of new roofing; this is to prevent a claim of substrate unsuitability at a later date. Require the Contractor to flush and clean all roof drains before beginning re-roofing work and to verify that the drains are still clean after completion of re-roofing work.

7. **Blocking:** Blocking and nailers for roofing should comply with Factory Mutual Loss Prevention Data 1-49 or roof system manufacturer's instructions and recommendations, whichever is most restrictive. See Section 06100 - Rough Carpentry for additional information.

8. **New Roof Protection:** Require the Contractor to control and restrict construction traffic over new roofing system. Where traffic or work is unavoidable, require effective temporary protection to prevent roof damage and wear. Prohibit use of oils, chemicals, solvents and other materials known to be damaging to new roofing system [the list of prohibitions can be obtained from the roof manufacturer). In single ply installations, the Designer should specify a special oil resistant membrane to be installed below all roof top equipment and in zones where oil may be produced or spilled. This will prevent deterioration of the prime roof membrane from oil and grease spills that occur during routine equipment maintenance. Containment areas and special oil separator drains may also be required depending on the location and machinery.

9. **Roof Walkways:** The Designer should specify and indicate on the drawings the appropriate type and location of roof walk ways to allow maintenance personnel to access roof top equipment without walking on or working on the roof. Refer to Section 11010 - Window Washing Systems for additional requirements for roof walkways.

10. **Roof Insulation:** Fire-resistive or fire-retardant insulation is preferred. Provide at least two layers of insulation with joints staggered between layers. Where possible, slope structural decks to drain and minimize the quantity of tapered insulation needed. Use roof insulation which meets the performance requirements listed previously and which provides at least the insulating value required by building codes. It is important to specify the total R value for the assembly. This allows for the consideration of other alternative materials.

    A. Polyisocyanurate Insulation: Use a maximum aged R-Value of 5.6 per inch thickness. This value is lower than the values typically published by insulation manufacturers. This lower value is recommended by the National Roofing Contractors' Association. Polyisocyanurate insulation may not comply with the following requirements.

    B. CFC Blowing Agents and the Ozone Layer: Do not use or specify any roof insulation which is produced with CFC [chloroflurocarbon] blowing agents which can damage the Earth's ozone layer.

    C. Recyclability: Consider the potential for recyclability when choosing roof insulation for any application where the roof insulation may need to be discarded in the future.

END OF SECTION

SECTION 07570 - TRAFFIC TOPPING SYSTEMS

1. **Traffic Topping Systems:** Traffic topping systems are waterproof traffic bearing membranes. These are commonly used at parking garages over occupied spaces and at balconies and terraces. Manufacturers of these products typically offer different grades of product to suit the intended traffic: vehicular, pedestrian, and so on.

2. **Sealants:** Sealants are usually an important part of a traffic topping system. For single source responsibility, all work related to traffic topping systems including surface preparation and sealants should be assigned to only one manufacturer and installer.

3. **Compatibility:** All components of the traffic topping system must be acceptable to the traffic topping system manufacturer and must be certified by the system manufacturer to be compatible. Surfaces to receive traffic topping systems must be checked for compatibility problems and accepted by the traffic topping system manufacturer's representative before the traffic topping system is installed. This is especially important for traffic topping placed over surfaces which may be contaminated with oil or other substances and for traffic topping placed over an existing traffic topping system.

4. **Traffic Topping Characteristics:** Traffic topping systems must be highly resistant to winter de-icing chemicals and should be slip-resistant.

5. **M.I.T. History:** M.I.T. has had problems with some traffic topping systems. Before selecting or specifying a system, the Designer should discuss M.I.T.'s experience with the Manager of Building Maintenance and other experienced Physical Plant personnel.

END OF SECTION

SECTION 07600 - FLASHING AND SHEET METAL

1. **Reference Standards:** Flashing and sheet metal work should comply with Sheet Metal and Air Conditioning Contractors National Association [SMACNA] “Architectural Sheet Metal Manual”. Specific metals such as copper should also comply with specific trade standards such as publications of the Copper Development Association. Refer to Section 04200 - Unit Masonry for other flashing requirements.

2. **Minimum Metal Thicknesses:** In general the following minimum guidelines shall apply:

   A. **Copper:** 16 ounce where fully supported and at least 20 ounce when not fully supported.

   B. Lead Coated Copper: 16 and 20 ounce copper as stated above with minimum 1.92 ounce lead coating [total weight of lead on two sides]. Follow SMACNA recommendations for applications in industrial locations and polluted urban environments. At M.I.T. this recommendation would likely apply to work immediately adjacent to chimneys, flues, fume hood exhausts, and other localized polluted environments. The resulting assembly must meet FM Class I-90 minimum.

   C. Aluminum: For highly visible work such as fascias, 0.050” is minimum with 0.063” preferred. For concealed work, 0.040” is minimum with 0.050” preferred. Since aluminum cannot be soldered, consider the methods of seaming and jointing. Specify and detail joints which are both visually acceptable and which offer long-term weatherability. The resulting assembly must meet FM Class I-90 minimum.

   D. Sheet Lead: One pound per square foot.

3. **Throughwall Flashings:** Membrane flashings such as W. R. Grace “Permabarrier”, and metal flashings are acceptable. Laminated flashings such as copper-paper are not acceptable.

   A. Limitations on Membrane Flashings: Do not use membrane flashings where the flashing is not fully supported, where the flashing will be exposed to sunlight, or where the flashing will be incompatible with sealants.

4. **Aluminum Finishes:** Clear anodized and color anodized should be Class 1 [at least 0.7 mils thick]. Some manufacturers offer Class 2 [0.4 mils thick] which is generally accepted for interior work only. Kynar 500™ based paint is the best choice for painted finishes; baked enamel paint finishes are cheaper, but should be avoided since there are problems with long term color retention and paint film performance.

5. **Galvanized Steel Flashings:** M.I.T. prefers to avoid galvanized steel flashings because of problems with corrosion and painting.

6. **Expansion Control:** Do not forget to show spacing, locations, and details of expansion joints in sheet metal work. Failure to control expansion often results in flashing failures such as flashing pulling out from reglets.

END OF SECTION

SECTION 07720 - ROOF ACCESSORIES

1. **Roof Access Hatches:** M.I.T. does not want roof access hatches since maintenance workers cannot easily and safely use ladders and ships stairs usually used with access hatches. Stairs with doors to the roof are preferred at M.I.T.

   A. Where roof access hatches are permitted, they should have insulated metal lids. The minimum acceptable access hatch size is 3'-0" by 2'-6"; larger units are preferred. Each hatch must be equipped with a padlock eye on the interior to restrict access to the roof unless the access to the roof hatch is in a locked, secured room.

   B. Access Doors: In general, access doors should not be locked from the outside; free entrance to the building from the roof for egress purposes is desired, except when the roof height or other conditions indicated that this would cause problems with unauthorized entrance. Access doors should be constructed of 16 ga. galvanized steel with seamless, welded edges and faces to resist water penetration. Provide a surface mounted, heavy duty overhead door holder. Provide secure attachment to the door to resist the force of wind from tearing the holder away from the door. Refer to Section 08100 Steel Doors for additional information.

   C. Alarms: Roof access hatches and doors may need to be protected by security alarms. The Designer should verify whether an alarm is needed.

2. **Heat and Smoke Vents:** These should be used as needed to meet codes and to vent the products of combustion to the exterior. Heat and smoke vents must be easily opened from the exterior to permit firefighters to open the vent from the roof.

   A. Testing: After installation and before acceptance by M.I.T., each heat and smoke vent must be field tested to ensure that it will properly open automatically. After testing, all melted fusible links and other damage shall be replaced to restored to "ready to go" status.

3. **Roof Equipment Curbs:** These are sometimes specified with the equipment and sometimes specified separately in this section. Coordinate with your mechanical engineers and other consult-ants to ensure that equipment curbs are properly covered and covered only once. In general, metal curbs with insulated based are preferred, but the actual selection must be coordinated with the equipment to be supported. The roofing and flashing details of the curb should be reviewed prior to selection to ensure that a simple, easy to maintain and repair condition is created.

END OF SECTION

SECTION 07820 - SKYLIGHTS

1. **Single Source Responsibility:** Require single source responsibility for skylights including the entire skylight assembly, all sealants, and glass and glazing.

2. **Structural Performance:** The entire skylight assembly should be engineered by the skylight manufacturer to safely support all loads required by codes. If special loads are required such as loads due to special skylight cleaning techniques; these should be specified.

   A. New and Replacement Skylights: All new and replaced skylights must be capable of supporting a concentrated load of 200 pounds minimum applied perpendicular to the surface of the skylight in a one square foot area. Refer to OSHA 1910.23(a)(4) and ANSI A1264.1-1989 3.4.

   B. Existing Skylights: All existing skylights that are being modified or altered must either be made to support a load of 200 pounds as described above or be guarded by a standard skylight screen or a fixed standard railing on all sides where it is exposed to pedestrian traffic, including maintenance and repair personnel. Refer to OSHA 1910.23(a)(4) and ANSI A1264.1-1989 3.4.

3. **Air and Water Infiltration:** Limit air infiltration to maximum of 0.10 cubic feet per minute per square foot of skylight area when tested at at least 6.75 pounds per square foot pressure difference. Under test, there should be no water infiltration at at least 9 pounds per square foot pressure difference. In practice, no uncontrolled water infiltration of any quantity at any time is acceptable. Water which is collected and wept to the exterior is generally acceptable.

4. **Condensation Control:** “Leaks” in skylights are sometimes uncontrolled condensation forming on the interior of the skylight assembly. Each skylight system should include interior gutters to collect and conduct condensation to the exterior through weeps. Soldered joints in interior gutters sometimes leak and should be avoided. Steeply pitched skylights encourage condensation to run to the gutters instead of dripping. Framing for the skylight should have a Condensation Resistance Factor of at least 52 per AAMA 1502.7. Low interior humidities will help control condensation; discuss this with your mechanical engineer.

5. **Skylight Framing Finishes:** Clear anodized and color anodized should be Class 1 [at least 0.7 mils thick]. Some manufacturers offer Class 2 [0.4 mils thick] which is generally accepted for interior work only. Kynar 500™ based paint is the best choice for painted finishes; baked enamel paint finishes are cheaper, but should be avoided since there are problems with long term color retention and paint film performance.

6. **Glass:** When used over conditioned space, insulated glass units should be used. For the exterior pane, glass which is strong in bending like tempered glass is often used. The exterior pane is often tinted or coated to control heat gain. The inner pane must be laminated safety glass; tempered glass is not acceptable in this location since it would easily fall from the skylight when broken [laminated glass is more likely to stay broken within the frame]. Wire glass is not safety glass and cannot be used in any skylight. When replacing old wire glass in an old skylight use the glass indicated above and not wire glass.

7. **Sealants:** Silicone sealants are often used in skylights. Structural silicone glazing is commonly used at horizontal glazing joints where an exterior bar or cap strip would obstruct the flow of water or snow. Vertical joints often have compression glazing gaskets with bolted on compression plates; the compression plates are often covered with a decorative snap-on cover.

8. **Plastic Dome Skylights:** If individual plastic skylights are ganged together into a large skylight assembly, the entire assembly must slope to drain in at least one direction to prevent water from standing between the skylight modules.

END OF SECTION

SECTION 07900 - SEALANTS

1. **Sealant Types:** The following types of sealants are preferred:

   A. Typical vertical exterior building joints: Non-sag, multi-part polyurethane or silicone.

   B. Typical horizontal exterior building joints: Self-leveling, multi-part polyurethane.

   C. Typical interior joints at toilet rooms, plumbing fixtures, and wet areas: Mildew resistant silicone.

   D. Typical interior sealant: Acrylic latex.

   E. Concealed acoustical sealant: Acoustical sealant.

   F. Glazing sealant: See Section 08800 - Glass and Glazing.

2. **Forgotten Locations:** The following locations often need sealant and these should be covered in the Contract Documents to avoid Change Orders:

   A. Top of wall base at irregular walls and rough substrates like masonry.

   B. Perimeter of interior door, sidelight, and borrowed light frames.

   C. At joint between acoustical ceiling wall angles and irregular walls.

   D. At countertops, where perimeter of countertops abut walls, backsplash and other vertical surfaces.

   E. At inside [concave] corners in ceramic tile wall finishes.

3. **Odors:** Sealants selected should be of low toxicity and produce little or no odor. Arrangements must be made to isolate and ventilate the area during the work and notify the occupants of the adjoining areas. Contact IHO for additional advice.

4. **Sealant Colors:** At exterior, choose sealant colors which are known to be stable and durable. Sealant colors are often unstable and can dramatically change the look of a building when they bleach white. Require proof of the color stability or a very tight warranty.

5. **Tests:** Sealant manufacturer's typically recommend project specific tests to ensure that the correct primer and sealant is used. Both lab tests using samples of window finishes and field tests for adhesion can be done and are highly recommended. Sealant manufacturer's catalogs often include information on testing.

6. **Joint Design:** Sealant has limited movement capability. Each type of sealant has a different movement capability with the best sealants only offering 50% movement under ideal conditions. Check the movement capability when selecting a sealant and when designing the joint width. Since each joint may only accommodate a small movement, several joints may be needed or unusually wide joints may be needed.

7. **Flammability:** Sealers and fillers should be non-flammable or have high flash point.

8. **Backer Rods:** Backer rods should be specified where appropriate to provide effective installation and to limit the amount of sealant used to fill a gap. The exact type of backer rod is related to the type of sealant to be used and must be coordinated to avoid problems in the field.

END OF SECTION

DIVISION 8 - Doors and Windows

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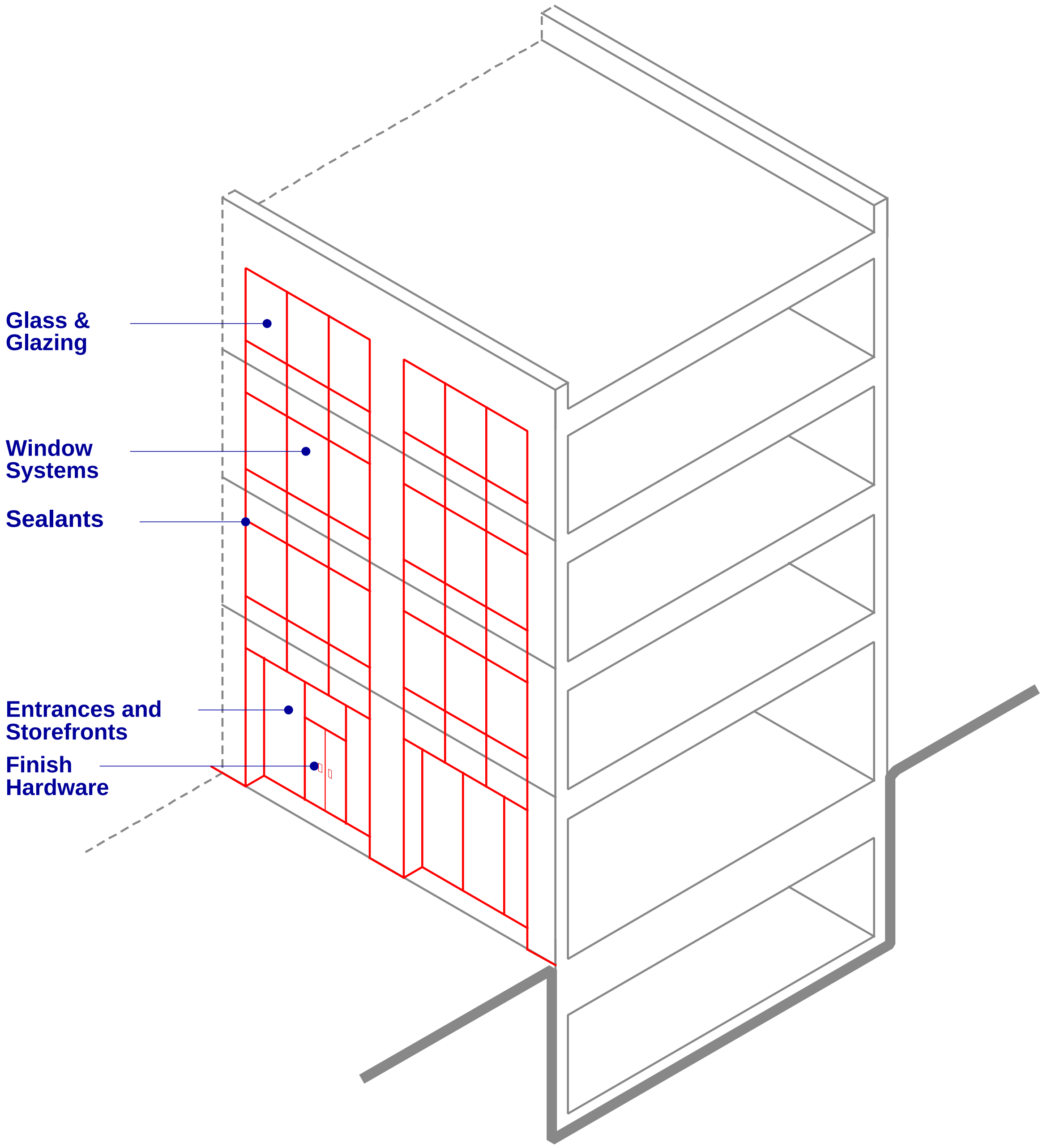
Glass &
Glazing
Window
Systems
Sealants
Entrances and
Storefronts
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Hardware

SECTION 08100 - STEEL DOORS AND FRAMES

1. **Door Sizes:** Typical M.I.T. doors are 7'-0" high. The following are some common door widths at M.I.T., verify required door widths with the use of the space and special equipment movement requirements:

SPACE	TYPICAL DOOR WIDTH
Laboratory or Research to Corridor	Check program requirement; equipment may need unusually wide doors or pair doors. Doors *must* open out.
Laboratory to Laboratory	Check program requirement; may need extra wide doors to move equipment.
Machine Room	5' or 6' opening; pair 3'-0" and 2'-0" or two 3'-0"
Mechanical Equipment Room	5' or 6' opening; pair 3'-0" and 2'-0" or two 3'-0"
Electrical/Telephone Room	5' or 6' opening; pair 3'-0" and 2'-0" or two 3'-0"
Janitor's Closet with small storage	3'-0" single
Custodial storage for floor machines	5' or 6' opening; pair 3'-0" and 2'-0" or two 3'-0"
Custodial storage for towels, supplies	5' or 6' opening; pair 3'-0" and 2'-0" or two 3'-0"
Mail Room, Shipping/Receiving	5' or 6' opening; pair 3'-0" and 2'-0" or two 3'-0"
Rubbish Room	5' or 6' opening; pair 3'-0" and 2'-0" or two 3'-0"
Typical Office	3'-0" single
Typical Classroom, Seminar Room	3'-0" single
Typical Toilet Room	3'-0" single
Door at Tunnels	Match the width of the tunnel.
Door at Bridges	Match the width of the bridge.
Door to Roof	3'-0" single

   A. Maneuvering Clearances: Door widths must always accommodate barrier-free accessibility requirements. Required clearances on both sides of doors vary greatly depending on the operation and type of hardware on the door. The Designer should carefully review the ADA and AAB for specific requirements pertaining to clearances.

   B. Laboratory Doors: Because of the potential hazards that exist in laboratories, M.I.T. requires that *all* laboratory doors open out in the direction of egress travel.

2. **Vision Panels in Doors:** Provide vision panels in major public area doors and all laboratory doors. Vision panels in doors shall be safety glass. In fire-rated doors, wire glass may be used, but the wire glass must be laminated safety glass also; wire glass alone is not safety glass. Vision panels should be located to allow maximum viewing to the opposite side of the door to reduce accidents with wheelchair users, children and persons with disabilities. The Designer should consider the use of 5 x 20 vision panels in lieu of 10 x 10 in fire rated doors.

3. **Interior Steel Doors:** Provide 1-3/4" thick Steel Door Institute grade II - heavy duty, 18 gage minimum face sheets, seamless construction.

   A. Acoustical Steel Doors: In addition to above, for doors to noisy machine rooms, television rooms, audio rooms, and elsewhere noise control is needed, provide acoustical insulated doors with perimeter soundstripping and minimum STC of 45. Special applications may require even higher STC performance.

4. **Exterior Steel Doors:** Provide 1-3/4" thick Steel Door Institute grade III, extra heavy duty, 16 gage minimum face sheets, seamless construction. Provide exterior doors fabricated from galvanized sheet steel with closed, seamless tops and no places to catch and hold water.

A. Insulated Doors: When heated space is on one side, provide thermally insulated doors with minimum R Value of 7.5. Since nearly all heat loss is due to air infiltration, provide fully weatherstripped doors including head, jambs, and door bottom seal.

5. **Interior Steel Frames:** Provide minimum 16 gage frames with fully welded seamless construction to the greatest extent possible. KD frames may be used only with approval from the M.I.T. Project Manager.

   A. Frame Stops: Provide stops made to subfloor, except at laboratories and other spaces needing extensive cleaning, consider using hospital stops held about 3” above floor.

   B. Frames and Transoms: In some M.I.T. buildings, frames extend to ceiling and require transoms so that doors of standard heights can be used.

6. **Exterior Steel Frames:** Provide minimum 14 gage frames with fully welded seamless construction to the greatest extent possible. Provide frames fabricated from galvanized sheet steel.

   A. Interior Wet Areas: Use galvanized “exterior” frames. Examples: Animal holding rooms, cage wash rooms, and similar wet areas.

7. **Fire-Rated Steel Door Assemblies:** Comply with requirements above and provide door assemblies with listed frames, classified doors, listed closers, listed lock/latch with minimum 3/4” throw, and steel bearing type hinges all acceptable to local authorities having jurisdiction. Provide door assemblies and clearances to comply with NFPA 80.

   A. Hardware Coordination: Check hardware for fire-rated doors. Fire-rated doors must be self-closing and must latch; they cannot have hold-open devices which prevent the door from closing in a fire. Refer to Section 08700 for Hardware requirements.

   B. Door Louvers: Louvers in fire-rated doors must be fire-rated steel louvers with self-closing dampers.

8. **Corridor and Stair Fire/Smoke Door Assemblies:** To facilitate maintenance and movement of equipment, furnishings, and other items, provide electromechanical hold-open closers with automatic release interconnected into building fire/smoke alarm system. Avoid use of magnetic holders which may require degaussing and which may hold doors open even when electrical current is disconnected.

   A. Electrical: Electromechanical closers require coordination with electrical and fire-alarm drawings and specifications.

   B. Finish Hardware: Electromechanical closers require coordination with hardware specifications.

   C. Limitation: Do not use any type of hold-open devices including fire-rated devices at enclosed stairwells. Stair doors at M.I.T. must be self closing and latching at all times; stair doors which normally stand open may encourage building occupants to block stair doors open.

   D. Miscellaneous Hardware: Thresholds, closers, operators, automatic doors and door opening forces have specific requirements outlined in the ADA and AAB.

9. **Double Leaf Doors:** At least one leaf of the pair of doors shall meet the requirements for an accessible door.

10. **Clear Width:** Typically, doors installed in standard frames must be a minimum of 36" wide to comply with the requirements for accessibility. Non-standard conditions must be carefully reviewed based on the ADA and AAB.

END OF SECTION

SECTION 08200 - WOOD DOORS

1. **Minimum Door Sizes:** See table in Section 08100 - Steel Doors and Frames.

2. **Interior Flush Wood Doors:** Provide 1-3/4" thick Architectural Woodwork Institute Premium Grade PC-5 construction. Specify minimum face veneer thickness.

   A. Warranty: Provide Life of Installation warranty. Since large cut-outs for glass panels and louvers, and routing of door faces for architectural effect may invalidate warranties, check your design with door manufacturers to ensure that the warranty will not be invalid.

3. **Exterior Flush Wood Doors:** The use of exterior flush wood doors is discouraged since long term durability and maintenance may be a problem. For renovation work, exterior flush wood doors may need to be used to match existing doors.

4. **Interior Stile and Rail Wood Doors:** Provide 1-3/4" thick Architectural Woodwork Institute Premium Grade construction.

   A. Warranty: Provide Life of Installation warranty.

5. **Exterior Stile and Rail Wood Doors:** Provide 1-3/4" thick Architectural Woodwork Institute Premium Grade solid wood construction; do not use veneer construction for exterior doors.

   A. Warranty: Two years from Date of Substantial Completion.

6. **Fire-Rated Wood Door Assemblies:** Comply with requirements above and provide door assemblies with listed frames, classified doors, listed closers, listed lock/latch with minimum 3/4" throw, and steel bearing type hinges all acceptable to local authorities having jurisdiction. Provide door assemblies and clearances to comply with NFPA 80.

   A. Since fire-rated wood doors often have little wood in the door core you must: 1] through-bolt door hardware, 2] provide fire-treated laminated stiles and rails with improved screw holding resistance, or 3] use steel doors.

   B. Hardware Coordination: Check hardware for fire-rated doors. Fire-rated doors must be self-closing and must latch; they cannot have hold-open devices which prevent the door from closing in a fire. All doors that are required to be accessible to the disabled must have hardware that does not require tight pinching, grasping or twisting of the wrist. Doors that latch will typically use lever type hardware.

   C. Door Louvers: Louvers in fire-rated doors must be fire-rated steel louvers with self-closing dampers.

7. **Veneers for Painted Doors:** Provide Medium Density Overlay for interior flush doors; Clear Pine or Fir for interior stile and rail doors; and Clear Pine, Fir, Mahogany, or Oak for exterior stile and rail doors.

8. **Veneers for Transparent Finished Doors:** Provide species as proposed by Designer and approved by MIT Project Manager. Take care when specifying veneer matching including pair matching of pair doors, and end matching of transoms.

9. **Finishes:** Avoid specifying factory finishes for wood doors since many of these finishes are difficult to touch-up and re-coat on site. M.I.T. prefers doors to be field finished with polyurethane for interior doors or alkyd varnish for exterior doors; oil finish requires excessive maintenance and does not weather uniformly.

END OF SECTION

SECTION 08305 - ACCESS DOORS AND PANELS

1. **Minimum Access Door and Panel Sizes:** Access door and panel sizes must be large enough to accommodate the intended use and to comply with M.I.T. Safety Office "Confined Space Entry Procedures".

Type of Use	Minimum Size
Reach-In Access Door	12" x 12"
Access Door for Torso Only	24" x 24"
Access Door for Complete Body Passage	30" x 30"

2. **Access Door Locations:** Provide access doors in drywall, plaster and other inaccessible finishes to provide maintenance access to valves, controls, junction boxes, and other items which otherwise would be inaccessible.

3. **Finishes:** Typically factory prime and field paint access doors to match adjacent wall or ceiling. In highly finished areas [such as main lobbies] or corrosive environments, special finishes may be needed such as stainless steel. Access doors that will accept the finish material of the ceiling are also available and will provide a continuous, flush appearance in special areas where that level of treatment is required.

4. **Locking:** Small access panels are often not locked, but to discourage tampering and unauthorized access, most access doors and access panels for important valves or controls should be equipped with screw-driver operated cam locks to hold the door flush when closed.

5. Fire-Rated Access Door Assemblies: Ensure that all access doors in fire-rated assemblies are UL listed, rated, and labeled to maintain the assembly rating. Provide manufacturer's standard self-latching cam.

6. **Specification Coordination:** Access doors are often specified in Division 15 and 16 specifications and the engineers often use their standard boilerplate spec which often does not comply with these guidelines. Review the Division 15 and 16 specs and ensure that these guidelines have been accommodated.

END OF SECTION

SECTION 08330 - OVERHEAD DOORS

1. **Types of Overhead Doors:** M.I.T. has had lots of problems with overhead doors. Everything related to overhead doors must be extra-heavy-duty. The following are common types of overhead doors:

   A. Overhead Coiling Doors and Grilles: These are large doors going to floor with small curtain slats [doors] or rods [grilles]. Doors can be made from steel, stainless steel, or aluminum, but aluminum cannot be used for fire-rated doors. Open grille curtains can be used to permit ventilation and vision; these often are specified in a "stack bond" or "running bond" pattern.

   B. Overhead Coiling Counter Doors: These are basically the same as the above, except the doors are smaller and often stop at the top of a service or retail countertop.

   C. Sectional Doors: These run on tracks and when open are horizontal [parallel plane with the floor]. This type of door takes more room than coiling doors, but offers advantages such as reduced cost, better insulating values, ability to have man-doors within overhead door, and ability to have lots of glass in door. Because of these advantages, sectional doors should be used wherever possible.

2. **Safety Issues:** Overhead doors should not be used in egress pathway and cannot be used for fire-doors, except for counter and window fire shutters. Motorized doors should have bottom safety edges to automatically stop and reverse door when door touches an obstruction.

3. **Door Operation:** Manual doors are acceptable when door is of a manageable size and when there is no need for remote operation. For manual doors, provide push-up and pull-down operation only for very small doors [up to 100 square feet] and provide gear operated chain hoist for larger doors.

   A. Electric Doors: Provide electric operation with motor size as recommended on tables provided by door manufacturers [motor horsepower is related to frequency of use and size of door]. Provide manual chain hoist back-up operation for all motorized doors.

4. **Self-Closing Fire-Doors:** Overhead doors cannot be used for fire doors, except for fire shutters at windows or countertops. The Designer must verify that there is sufficient clearance to reset self-closing fire shutters at windows and countertops.

5. **Door Hoods:** Provide metal hoods [enclosures] where the door barrel is exposed to view in finished areas and for all exterior work to improve energy conservation. Hoods typically match door curtain in material and finish.

6. **Finishes:** Galvanized steel, stainless steel, clear anodized aluminum, and color anodized aluminum are acceptable finishes. Factory and field painted doors may be a problem for coiling doors since the door can be scratched at the "hinges" when coiling. Painted sectional overhead doors are acceptable.

7. **Locking:** Overhead doors can have latches [slide bolts] or keyed locks. Review the need for keyed locks and use only where truly needed.

8. **Coordination:** Coordinate electrical requirements and check electrical drawings and specs for electric operated overhead doors.

   A. Overhead Door Tracks and Guides: Always recess or position tracks and guides in a protected location outside the opening. Do not permit tracks and guides to reduce the opening width. M.I.T. has frequent problems with damage to tracks and guides from traffic through the doorway.

END OF SECTION

SECTION 08410 - ALUMINUM ENTRANCES AND STOREFRONTS

1. **Types of Doors:** Aluminum Entrances are commonly used throughout the campus. Although narrow stile and rail doors may have some pleasing architectural characteristics, M.I.T. has had problems with these types of doors. Light or medium duty narrow stile doors often rack and warp under normal use conditions. The alternative is to use doors with heavy-duty welded construction such as Kawneer "Tuff-Line" or Kawneer "Entara XD". Typically, the stile must be a minimum of 4" wide to accommodate the standard M.I.T. lockset.

   A. Glass in Doors: Insulated glass units in entrance doors probably aren't necessary for energy conservation [most energy lost at door cracks and not through the glass] and insulated glass units will require more maintenance, so typically use a single piece of minimum 1/4" tempered safety glass.

   B. Revolving Doors: For energy conservation, revolving doors should be used for major building entrances [see Section 08470]. These doors are not allowed as access for the persons with disabilities. An adjacent, accessible entrance is required in conjunction with revolving doors.

2. **Door Hardware:** Hardware for aluminum entrances should be specified with the entrances in the Aluminum Entrance spec section and not in the Finish Hardware spec section; this is to reflect the way the hardware will actually be provided. You should reference the Finish Hardware spec for the keyed cylinders and you should specify the doors to be provided with locks "less cylinders". In locations that have electric door operators for the disabled, remember to coordinate the self-latching or locking function with the electric strike to allow the door operator to open the door

   A. Pivots/Hinges: Use Offset Pivots or Butt Hinges with at least 3 pivots or butt hinges per leaf. Do not use pivots concealed in the floor. Confirm that the hardware specified will meet the required criteria for accessibility as defined by the ADA and the AAB.

   B. Exit Devices: Exit devices [panic hardware] will often be needed. Von Duprin is the M.I.T. standard exit device manufacturer. Do not use recessed panic devices [such as Kawneer "Paneline"] since M.I.T. has had major maintenance problems with this type of device. Concealed rod devices are a maintenance problem and should be limited solely to architecturally significant areas where other solutions are not available or acceptable. The M.I.T. Project Manager will assist the Designer in determining which areas are appropriate for the use of concealed rod devices.

      1) Pairs of doors that are required to latch and are without removable mullions: Use exposed vertical rod type devices.

      2) Single doors or pairs of doors with a removable mullion: Use Rim-type panic devices.

      3) High traffic and cart traffic areas: Exposed devices should be used regardless of architectural significance.

   C. Locks: Typically use heavy-duty mortise locks similar to those specified in Section 08700 - Finish Hardware. Specify the locks to be provided without key cylinders; key cylinders to be provided under Section 08700 - Finish Hardware so MIT's master keying system can be maintained. Adams-Rite locksets do not work with the M.I.T. standard bicentric cylinders. Avoid locks with strikes in the floor; these get filled with dirt quickly making the door unlockable and require frequent cleaning and maintenance.

D. Closers: Use surface mounted, parallel arm closers to the greatest extent possible. Where desired for aesthetic reasons, concealed closers may be specified. However, concealed closers are difficult to maintain. The Designer should consult with the Supervisor for Building Maintenance prior to specifying concealed closers. Do not use floor closers since they can be easily damaged by water, ice, and dirt, and are often difficult to maintain and replace.

E. Weatherstripping: Specify weatherstripping at the entire perimeter of the door including door bottoms. Require weatherstripping to be easily replaceable without major disassembly of the door or frame.

F. Thresholds: Thermally broken aluminum thresholds are most often used. Use only barrier-free thresholds, which are only 1/2" in height from the floor.

G. Automatic Entrance Operators: These should be electromechanical, surface mounted devices to facilitate access and maintenance. The preferred idea is to have the door work typically as a normal push/pull door and have the electric operator used only for persons with disabilities through the use of push button switches on both sides of the door. Several switches and control types are available: electric eyes, pressure mats [like old supermarkets], infrared or microwave motion detectors [like new supermarkets], push buttons, and other switches. Take care in choosing switch types and think about traffic patterns. Motion detectors often read cross-traffic and open doors needlessly. Some switches open the door for all traffic not just handicapped traffic. You must protect people from being hit by opening doors; this can be accomplished by additional switches which sense the presence of a person in the door path [pressure mats or infrared detectors] or by railings [often seen at supermarkets]. Use caution in placing rails so that the required accessibility clearances around the doors are not obstructed.

3. **Storefronts:** Use thermally broken storefronts with Condensation Resistance Factor at least 52 or higher. 1" insulating glass will typically be used. Tempered safety glass will often be required [adjacent to doors, within 18" of floors, and at any location which someone could mistake for an opening during panic egress].

4. **Door and Frame Finishes:** Clear anodized and color anodized should be Class 1 [at least 0.7 mils thick]. Some manufacturers try to use Class 2 [0.4 mils thick] which is generally accepted for interior work only. Kynar™ paint is the best choice for painted finishes; baked enamel paint finishes are cheaper, but should be avoided since there are problems with long term color retention and paint film performance.

5. **Hardware Finishes:** Use only solid stainless steel, brass, or bronze for hardware on exterior doors; do not use plated finishes [thin plating over steel or brass] or aluminum hardware. aluminum hardware is too soft and wears too quickly. The finish on aluminum pulls and pushes wears too quickly. Door closers on major public doors should have metal covers and not plastic.

6. **Sliding Doors:** Where these doors are specified, the Designer must be careful to consider the egress requirements of the space and the function of the door. Also note the strict MSBC requirements for use and design in Section 812.4.4.

END OF SECTION

SECTION 08470 - REVOLVING DOORS

1. **General:** Revolving doors should be used at major building entrances to save energy. Stainless steel, bronze, ornamental metal clad aluminum, and aluminum doors may be used. An additional, adjacent door is required to provide an accessible entrance for the disabled.

   A. Door Size: 7 feet diameter is the minimum; 7'-6" and 8'-0" would be better. Verify that the door manufacturer has successful experience making the size door required.

2. **Manual Doors:** Are best for MIT's uses. Adjustable speed governors shall be used to control excessive door speed.

3. **Egress:** Door wings shall be collapsible in the direction of egress when pressure is applied.

4. **Door Wings:** Use heavy-duty welded corner construction; avoid use of narrow stiles and rails. Provide easily replaceable brush sweeps at door edges to seal against enclosing drum.

5. **Entrance Mats:** Use only terrazzo or stone within revolving door drum. If stone is used, granite is preferred. Do not use metal grate type mats within a revolving door, since they must be custom fabricated to fit the circular door space and are very expensive to replace. Do not use mats inside the revolving door drum. The mats do not resist wear well and will heave causing the door to bind and eventually warp.

6. **Finishes:** See finish guidelines in Section 08410 - Aluminum Entrances.

7. **Locks:** Provide heavy-duty deadbolt locks which can accommodate the cylinders used in M.I.T.'s master key system. If the lock used cannot accept an M.I.T. cylinder keyed into the master key system, a padlock may be attached to the door [to the great dismay and horror of the Architect].

   A. Avoid locks with strikes in the floor; these quickly get filled with dirt making the door unlockable and floor strikes require frequent cleaning and maintenance. Use locks with bolts that set horizontally.

8. **Safety Issues:** Specify safety glazing for revolving door wings and enclosures. Provide decals or other marking on large glass panels near eye level as a warning to help prevent people from walking into glass.

9. **Previous Experience:** M.I.T. has had poor results with BWN Industries and good results with International Steel and Crane.

END OF SECTION

SECTION 08500 - WINDOWS

1. **Windows:** Aluminum windows are the most common type of metal window used on new work at MIT. Replacement window work often tries to match the original windows. The Main Group Buildings have steel windows [which are often in poor shape due to their age], Teak windows are used in a few buildings [with problems related to the finishes], and some of the World War II era buildings have residential type wood windows.

   A. Types of Windows: You can use Double Hung, Single Hung, Projection, Hopper, Awning, Casement, or, in specific locations, Fixed. Awning and hopper windows are often preferred since windows are frequently left open by building occupants and awning and hopper windows resist wind damage and water penetration better than most other window types. Swing-in hopper windows sometimes obstruct interior furnishings and sills. Casement windows and projecting windows which are exposed to heavy wind loads are often damaged.

   B. M.I.T. Tradition: Every occupied exterior room with windows shall have at least one operable window. This is an important tradition and special authorization must be obtained to break this tradition.

   C. Limitation: Non-operable windows set into concrete may not be used at M.I.T. due to previous problems. Spaces not assigned to individuals (such as classrooms and corridors) should have fixed windows.

   D. Windows: U-value of 0.40 Btu/hr./s.f./°F minimum is required. This should be specified in the window section and not Section 07200.

2. **Aluminum Window Quality and Performance:** As a minimum, 45 pound structural test pressure windows should be used. Based on the industry standard [AAMA 101] this means an air infiltration maximum of 0.10 cubic feet per minute per foot of window crack length for operable windows when tested at 6.75 pounds per square foot pressure difference [equal to 15% of structural test pressure], and no water infiltration at 9 pounds per square foot pressure difference [equal to 20% of structural test pressure]. Higher test pressure windows should be used when higher wind loads are expected or required by building codes.

   A. Aluminum Window Finishes: Clear anodized and color anodized should be Class 1 [at least 0.7 mils thick]. Some manufacturers offer Class 2 [0.4 mils thick] which is generally accepted for interior work only. Kynar 500™ based paint is the best choice for painted finishes; baked enamel paint finishes are cheaper, but should be avoided since there are problems with long term color retention and paint film performance.

3. **Steel Windows:** Steel windows may offer some architectural advantage since sight-lines are typically smaller than similar size aluminum windows. When considering steel windows, check the Condensation Resistance Factor of the frame section since steel windows are often not thermally broken.

   A. Steel Window Quality and Performance: Generally the minimum acceptable performance should be the same as specified above for aluminum windows. In addition, crack tolerances as measured with a feeler gage and minimum weights of frame members and sections should be specified.

B. Steel Window Finish: Since steel can rust, steel window finishes are extremely important. The fabricated steel windows should be hot-dip galvanized to comply with ASTM A386, Class B2 [minimum], then phosphate treated to promote good adhesion between galvanized surface and primer. Specify epoxy primer at 4.0 to 6.0 mils dry film thickness followed by an aliphatic urethane topcoat at 1.5 to 2.5 mils dry film thickness. The relatively thick epoxy primer forms a substantial barrier to prevent rusting; the urethane topcoat provides a hard, abrasion resistant finish.

4. **Wood Windows:** Wood windows are discouraged for new buildings because of the poor maintenance track record. Wood windows may be used to replace existing wood windows.

   A. Wood Window Quality and Performance: As a minimum, comply with NWWDA Industry Standard 2-87 Grade 40 for structural performance and air and water penetration. Wood windows should be assembled with mortise and tenon construction and not just stapled together.

   B. Wood Window Finish: Do not use oil finishes. Re-oiling is a maintenance problem and the oil finish does not protect the wood as well as paint protects the wood. For factory painted wood windows, consider using a high performance wood finish such as PPG Polyurea/Polycron finish.

   C. Teak Windows: Teak exterior windows (such as Duratherm as installed in E23 and E25) should be factory finished to insure a consistent “weathered Look” over time.

5. **Insect Screens:** Screens are required for operable windows in residential buildings, mail rooms, and food service areas. Use aluminum wire and not fiberglass screen fabric. Aluminum screens won’t sag and are easier to maintain and repair. Screens should be hinged and operable only with a special tool so that only maintenance staff can open screens for window cleaning or maintenance. Screens should not be removable since there is no place to store screens. Screens in areas accessible to children such as high rise apartments should be child-proof to prevent falling from open windows.

6. **Window Hardware:** Specify that all operable hardware be stainless steel and very heavy-duty. Aluminum, Zamac, plastic, and normal steel are not acceptable.

7. **Mock-Ups:** Where window wall and curtain wall systems are specified for new buildings, a full size mock-up should be specified. Coordinate this with the Unit Masonry Section.

8. **Testing:** For all buildings, the Designer should include the requirement for laboratory testing of windows, curtain walls and window walls.

END OF SECTION

SECTION 08700 - FINISH HARDWARE

1. **Finish Hardware:** This section should cover hardware for doors, except hardware for aluminum entrances, overhead doors, revolving doors, and similar “packaged” door assemblies which is typically specified with the door package. This section should specify the lock cylinders for all doors including entrances and overhead doors, so all doors will be keyed into M.I.T.’s keying system.

2. **Hardware Finishes:** Use only solid stainless steel, brass or bronze and do not use plated finishes on exterior doors. Plated finishes are acceptable for interior doors. Standard M.I.T. finishes are US10 (bronze, 612) and US 26D (dull chrome 626).

3. **Hinges:** Use fully mortised, 5 knuckle, flat tip, commercial quality hinges. Use ball bearing hinges for all doors with closers. Check hinge manufacturers’ tables for door frequency of use and hinge recommendations. Use Non-Removable Pin [NRP] hinges where security is a concern and for all exterior out-swinging doors.

4. **Keying System:** There are two masterkey systems used on campus: Yale 6 and 7 pin bicentric system and the Schlage Primus system. Both systems are maintained in house by the M.I.T. locksmiths. No non Institute cylinders are to be installed on campus. All mortise locks should be ordered “less cylinder”. The Yale compression spring collar that is furnished with the Yale cylinders is not compatible with the M.I.T. standard lockset (Schlage 9000 series mortise set). Provide blocking rings (spacers) when required.

   A. For projects needing less than 10 locks, locks will be furnished by M.I.T. for installation by the Contractor.

   B. For projects needing more than 10 locks, the Contractor shall provide the locks to comply with M.I.T.’s instructions and to suit the existing masterkey system.

   C. All cylinders and keys will be provided by M.I.T. for installation by the Contractor. The Designer shall require the Contractor to confirm the type of cylinders to be provided by M.I.T. in advance and coordinate the cylinders with the type of locks to be used. The keying meetings shall include an Institute locksmith to assist with the initial ordering of hardware and keying designations.

   D. All cylinders that are removed from existing installations shall be returned to M.I.T. to be reused. It should be stated in the specifications and on all demolition drawings that no cylinder or lockset shall be discarded by a Contractor.

5. **Locks and Latches:** The Institute standard is Schlage L9000 series mortise lockset. This brand and series is the only mortise lockset to be used on campus.

   A. The following is a list of the lock functions to be used:

L9050-06L	Office
L9010-06L	Passage
L9040-06L	Privacy
L9060-06L	Apartment
L9070-06L	Classroom
L9080-06L	Storeroom (Mechanical rooms, Transformer Rooms, etc.)

   B. Levers: For nearly all locks and latches including replacement of existing locks and latches which may currently have knobs, M.I.T. should use levers to comply with barrier-free accessibility requirements. The standard is the LC lever as manufactured by Schlage.

C. Flush Knobs: At animal cage rooms and other areas where there is heavy cart traffic, provide standard accessible hardware. To protect the hardware from traffic damage, provide molded door knob protectors constructed of Kydex™. Specify that the final product be supplied and installed with the smooth side out to facilitate cleaning.

D. Tactile Warning: All knobs and levers for doors opening into hazardous areas including radiation and isotope areas shall have knurled or roughened surfaces to serve as a tactile warning for visually impaired persons.

E. Combination Locks: Use Unican 1000-2M locks; these can accept the M.I.T. keying system. Comply with above requirements for lever handles and tactile warnings. Unican locksets may require special cores and cams in the cylinder.

F. Safety Issues: Do not use dead bolts, barrel bolts, or similar types of locks on egress doors. All egress doors must be accessible to persons with disabilities.

6. **Closers:** M.I.T. prefers LCN "Smoothee" and "Super Smoothee" series closers. Closers on all doors should have covers, metal if available. Use only parallel arm closers where the arm is exposed to the public. This will reduce the exposure to vandalism.

   A. Closers on all doors must meet the requirements of the ADA and AAB for opening force. This is an often overlooked element.

   B. Concealed Closers: These are not to be used at M.I.T. except at architecturally significant areas (as determined by the M.I.T. Project Manager) where an exposed closer would not be acceptable. Rixson is a preferred manufacturer of concealed closers. Do not use floor mounted closers.

7. **Door Stops:** Do not use door mounted friction stops on doors that are an egress element or part of an egress path.

8. **Fire Alarm System:** All hardware such as door hold-opens connected into the M.I.T. Fire Alarm System must comply with the M.I.T. Fire Alarm master specification [see guideline Section 16720].

9. **Allowances:** Do not specify hardware by allowance amount since this technique often just delays decision making and may not be cost effective.

10. **Exit Devices:** Exit devices (panic hardware) will often be needed. Von Duprin is the M.I.T. standard exit device manufacturer. Do not use recessed panic devices (such as Kawneer "Paneline") since M.I.T. has had major maintenance problems with this type of device. Concealed rod devices are a maintenance problem and should be limited solely to architecturally significant areas where other solutions are not available or acceptable. The M.I.T. Project Manager will assist the Designer in determining which areas are appropriate for the use of concealed rod devices.

    A. All doors must use 33, 88 or 99 Von Duprin mortise exit devices.

    B. Pairs of doors that are required to latch and are without removable mullions: Use exposed vertical rod type devices.

    C. Single doors or pairs of doors with a removable mullion: Use only Rim-type devices when you have two doors, otherwise use 33's, 88's or 99's.

D. High traffic and cart traffic areas: Exposed devices should be used regardless of architectural significance.

E. When using vertical rods, use guards on bottom half of door.

11. **Automatic Door Operators:** In cases where no other means of providing access for persons with disabilities exists, door operators may be required. The preferred manufacturer of these devices is Dor-O-Matic. The Designer should confirm with the Building Operations Manager regarding the preferred installer based on recently negotiated service contracts.

    A. When installing operators on pairs of exterior or interior doors, specify an separate controller in the operator for each leaf. This will provide independent manual operation of each leaf. The Designer should confirm and use only the proper size ball-bearing type hinge for the weight of the doors.

END OF SECTION

SECTION 08800 - GLASS AND GLAZING

1. **Glass:** When selecting glass, consider long-term maintenance issues such as: Will the glass be manufactured 20-30 years from now? A tinted or coated glass with a trendy color or appearance may be impossible to obtain in the future.

   A. Maintenance Stock: M.I.T. has no storage space for maintenance stock. In a new building, maintenance stock storage space could be programmed into the project.

   B. Glass Sizes: For maintenance simplicity, glass sizes in an area should be uniform.

2. **Energy Issues Related to Glass:** During the Design Development phase of a project the architect/ engineer is expected to identify economic opportunities to improve the energy performance of the project. These may involve specifying higher performance than the minimum standards required by these guidelines. These economic opportunities shall be evaluated through Life Cycle cost analysis.

3. **Insulated Glass:** Use insulated [dual pane] glass typically for exterior applications. Use only double sealed insulated units [some factory glazed windows provide single sealed insulated units as standard]. There are several local fabricators of insulated units and it is ideal if replacement units can be quickly and easily obtained locally.

   A. Warranty: M.I.T. wants a 10 year written warranty guaranteeing the insulated glass will not fog or exhibit any other evidence of seal failure.

   B. Sealant Compatibility: Ensure that glazing sealant is compatible with outer [secondary] edge seal of insulated units. Incompatible sealants could invalidate warranty on insulating units.

4. **Sealants:** Selected sealants should be of low toxicity and produce little or no odor. Arrangements must be made to isolate and ventilate the area during the work and notify the occupants of the adjoining areas. Contact IHO for additional advice.

5. **Safety Glass:** Check drawings to ensure that impact resistant safety glass is used where needed. All sloped glass [over 15° from vertical] and overhead glass must be laminated safety glass. Glass in doors and glass near doors must be tempered safety glass [tempered safety glass is much stronger than laminated safety glass]. Any glazed opening which could be mistaken for an open passage during an panic egress must have safety glazing and must have some type of warning graphic decals near eye level.

   A. Wire Glass is not safety glass and cannot be used where safety glass is required. Wire glass may be needed at fire-rated doors and partitions.

6. **Spandrel Glass:** Specify only "ceramic frit" type spandrel glass [a special coating is fused into the glass under heat resulting in an opaque coating which cannot be removed]. Do not permit "back painted" or film type spandrel glass since these coatings and films can easily flake and peel causing an expensive problem.

7. **Mirrors:** Mirrors should have copper and paint back-coatings to protect the silver mirror surface from tarnishing. Mirror should be mounted so the back can ventilate and so the mirror bottom edge is not resting on a countertop or backsplash; these mistakes often cause premature mirror failure at the bottom edge.

8. **Tinted and Reflective Film for Existing Glass:** Existing glass may be treated with a tinted or reflective film to improve energy performance characteristics. These films reduce the amount of light and energy passing through the glass; the energy in the form of heat may be trapped in the glass and cause thermal breakage. M.I.T. requires a warranty covering long term [minimum 5 year] film performance such as film peeling, film cracking and crazing, film discoloration, and at least a 1 year warranty covering glass breakage due to film caused thermal stress.

9. **Glass Cleaning:** For glass over 50 feet or four stories in height cleaned from the exterior, window cleaner's belt anchors or other safety devices are required. Anchors must be corrosion resistant and attached to window frames or building walls. Cast iron and cast bronze anchors do not meet codes. See Section 11010 - Window Washing Systems.

10. **Structural Silicone Glazing:** For interior butt glazed work, use high modulus structural silicone sealant. For exterior work, structural silicone glazing requires project specific engineering and testing. Structural silicone sealant must be protected from the weather by a weatherseal silicone sealant. The glazing details must be prepared and reviewed very carefully; special consultants may be needed.

END OF SECTION

DIVISION 9 - Finishes

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SECTION 09200 - PLASTER

1. **Plaster:** Plaster work may be needed to patch and repair existing plaster surfaces. Plaster may be used for surfaces in “public” areas and “M.I.T.” areas since the hardness of the plaster can be controlled by the specification. “Public” and “M.I.T.” spaces are defined in Appendix B.

   A. For veneer plaster, see Section 09215.

2. **Reference Standards:** Comply with applicable requirements of the following:

   A. ASTM C841, Specification for the Installation of Interior Lathing and Furring.
   B. ASTM C926, Specification for Application of Portland Cement Plaster.
   C. ANSI A42.2 and ANSI A42.3.
   D. United States Gypsum Company Systems Folder SA-920 [usually in Sweets]

3. **Gypsum Plaster:** Use gypsum plaster for typical interior plaster applications, except where Portland cement plaster is indicated below.

4. **Portland Cement Plaster:** Portland cement plaster is more water resistant and stronger than gypsum plaster. Use Portland cement plaster for exterior applications [stucco] and for interior applications where extreme strength and resistance to water and abuse is needed [locker rooms, shower room ceilings, heavy use corridors with moving carts, animal cage washing rooms, animal housing rooms, and other wet areas].

5. **Framing:** When choosing stud sizes, spacing and gages, remember that plaster work needs stiff framing. L/360 is typically the maximum acceptable deflection to reduce cracking.

6. **Metal Lath and Beads:** Use hot dip galvanized metal lath and solid zinc corner beads and control joints in wet areas.

7. **Control Joints:** Since plaster is brittle, control joints are needed to relieve stresses and to control cracking. Design the layout and spacing of control joints into your project.

8. **Corner Guards:** Since corner guards will most likely be needed at vulnerable areas, it is best if the Designer designs these into the Project. Corner guards should be “built-in” and not “added on” since corner guards added after the building is occupied may not look as nice. See Section 10260 - Corner Guards.

END OF SECTION

SECTION 09215 - VENEER PLASTER

1. **General:** Veneer Plaster is often used when a surface which is harder and smoother than drywall is desired. Since the lath in veneer plaster is a special gypsum wallboard, the total assembly will not be as hard or as durable as metal lath and plaster. Do not use veneer plaster as a cheaper substitute for metal lath and plaster.

   A. Locations: Veneer plaster is not to be used as a standard finish in any area and is normally restricted to use in highly finished architectural areas where there is extensive existing adjacent plaster, where historical considerations require or, where repairs are being done to existing plaster. It is not to be used as a standard finish in most renovation or new construction projects unless it can be demonstrated that it is cost effective to do so.

2. **Gypsum Lath [Veneer Base]:** Veneer plaster should be installed over veneer base which is a special gypsum board with a chemically treated paper face which improves the bond between the plaster and the base. In multiple layer applications, only the layer immediately beneath the plaster needs to be veneer base; other layers not in contact with the veneer plaster can be normal gypsum wallboard.

3. **Veneer Plaster**: M.I.T. prefers two coat veneer plaster applications with a minimum total plaster thickness of 1/8” [includes both layers]. If a one coat system is used, the thickness should be nominal 1/16”. A high strength [3,000 psi compressive strength] plaster such as U.S.G. “Imperial” should be used.

4. **Framing:** When selecting stud sizes, spacing and gages, remember that plaster work needs stiff framing. L/360 is typically the maximum acceptable deflection to reduce cracking.

5. **Control Joints:** Control joints are needed to relieve stresses and to control cracking. U.S.Gypsum guide specifications offer common control joints locations and recommendations. Design the layout and spacing of control joints into your project.

6. **Corner Guards:** Since corner guards will most likely be needed at vulnerable areas, it is best if the Designer designs these into the Project. Corner guards should be “built-in” and not “added on” since corner guards added after the building is occupied may not look as nice. See Section 10260 - Corner Guards.

END OF SECTION

SECTION 09250 - GYPSUM DRYWALL

1. **Drywall Limitations:** Due to heavy traffic and use, gypsum drywall corridor walls have not proven as satisfactory as concrete masonry or other hard wall systems. Drywall assemblies should not be used in wet areas such as animal rooms, cage wash rooms, large shower rooms, and other wet areas.

2. **Chase Walls:** Chase walls near toilet rooms and shower rooms which are large enough to permit access must be constructed to prevent vandalism and to resist penetration. M.I.T. has had problems with voyeurism and chase walls must be constructed to resist penetration.

   A. Possible Solutions: Provide a continuous layer of plywood between the framing and the gypsum wallboard or use masonry partitions. Use plywood only where permitted by building codes. Do not use fire-retardant treated plywood in structural applications.

   B. Do not locate exhaust louvers in chase walls, unless the louver is securely connected to ductwork and vision through the louver from the chase side is impossible.

   C. Provide ceramic tile on the interior wall surface of the toilet room to an appropriate elevation.

3. **Drywall Framing:** Check the manufacturer's stud tables and deflection tables when selecting framing size, gage, and spacing. It is a common problem for Designers to show framing which does not comply with the manufacturer's recommendations.

4. **Drywall Assemblies:** Use the Gypsum Association "Fire Resistance Design Manual" when selecting drywall assemblies. This reference graphically gives detailed descriptions, fire-ratings, and acoustical performance of common drywall assemblies.

5. **Drywall Boards:** Since there are several different types of drywall boards, the correct type must be clearly shown for each drywall assembly. Gypsum wallboard manufacturer's catalogs typically give a clear description of the recommended use of each board. M.I.T. typically requires 5/8" thick tapered edge drywall on all interior partitions.

   A. Use moisture-resistant boards for painted walls in toilet rooms and wet and humid areas, but do not use moisture-resistant board on ceilings [despite its name, it sags more than normal gypsum boards and it is not intended for horizontal applications where the frame spacing is greater than 12" o.c.). Moisture resistant boards should be specified in minimum thickness of 5/8" due to its lack of inherent strength. Do not use moisture-resistant gypsum as a substrate for ceramic tile; use glass mesh mortar units ["Wonderboard", "Durock" or equal; see Section 09300 - Tile]. Do not use MR board over vapor retarder if it will be covered with an impervious covering such as tile.

6. **Penetrations:** Penetrations through drywall assemblies and items recessed into the assembly need to be detailed or specified to ensure that fire and acoustical performance of the assembly is not compromised. Electrical and telephone outlets should not be back-to back in the same framed space. At typical offices, acoustical sealant and acoustical insulation should be originally installed to prevent the need for remedial work to satisfy complaints from building occupants.

7. **Building Deflection:** Drywall partitions are non-axially loadbearing and must be isolated from overhead building deflections. Detail or specify the type of deflection isolation [typically special deeper top runners with studs not attached to top runner]. At the deflection detail, consider acoustical isolation and firestopping.

8. **Corner Guards:** Since corner guards will most likely be needed at vulnerable areas, it is best if the Designer designs these into the Project. Corner guards should be “built-in” and not “added on” since corner guards added after the building is occupied may not look as nice. See Section 10260 - Corner Guards.

9. **Control Joints:** Relieves stresses and expansion and contraction across large ceiling and wall areas. Provide an adequate seal behind joint where sound and/or fire ratings are a prime consideration. Install control joints over studs placed back-to-back with 1/2" space between.

10. **Accessories:** Specify only galvanized metal accessories and trim for drywall work. Plastic accessories are not acceptable due to the flexibility and wavy appearance on long runs. When specifying extruded aluminum reveals and other special shapes, coordinate the finish on the metal accessories with the type of finishing material to be used.

END OF SECTION

SECTION 09300 - CERAMIC TILE

1. **Ceramic Tile:** Ceramic tile or terrazzo are the M.I.T. preferred finish for floors in toilet rooms. Refer to Appendix B for specific areas and their requirements. Ceramic tile, glazed clay tile, or glazed concrete masonry is the M.I.T. preferred finish for walls in high traffic toilet rooms. Since cost is often a major concern, epoxy painted moisture resistant gypsum drywall is acceptable for low to moderate traffic toilet rooms at offices and laboratories.

2. **Reference Standard:** Comply with the Tile Council of America "Handbook for Ceramic Tile Installation".

   A. Use the installation methods indicated and carefully read the "Recommended Uses" and "Limitations" portions. Review the "Wall Tiling Installation Guide" and "Floor Tiling Installation Guide" near the front of the reference book for advice on which installation system to use.

   B. Installation Standards: Generally, wall tile should be installed over framed walls to comply with TCA W244 [glass mesh mortar units].

3. **Thinset Flooring:** Since thinset flooring is intended for slabs on grade where no bending stresses occur, tile floors on structural slabs should not be thinset and should be set in compliance with TCA recommendations for the type of application and installation. On occasion the installation of tile can be made over the existing tile if the existing tile and substrate are sound. Careful consideration must be given to the adhesives, substrates, existing fixtures, fittings and sleeves through the floor to execute this type of application successfully. Refer to the TCA Handbook for Ceramic Tile Installation TR711 - TR713 for information.

4. **Waterproofing at Flooring:** Where rooms with tile floors have floor drains or there is large quantities of water, the use of a waterproofing layer beneath the tile and flashed into the drains is required. It is also recommended to carry the membrane up the wall behind the finish. Refer to specific manufacturers instructions.

5. **Grout:** Review the "Grout Guide" near the front of the reference book for advice on which grout system to use.

6. **Lighting:** Avoid the use of "wall washer" lighting at wall tile since this type of lighting creates shadows which exaggerates the "lippage" between adjacent tiles. Poor examples of wall washing at wall tile can be found in many underground subway stations [like portions of Park Street].

7. **Safety Issues:** Polished stone thresholds can be very slippery and often cause accidents. Stone thresholds should be textured or grooved to create slip-resistant surfaces. Floor tile should have 7-1/2% abrasive grain for improved slip-resistance. The AAB currently requires that all interior thresholds be flush.

END OF SECTION

SECTION 09400 - TERRAZZO

1. **Terrazzo:** Use terrazzo or equivalent long wearing floors such as stone or ceramic tile for public circulation areas as defined in Appendix B.

   A. Odors associated with epoxy terrazzo floors are very strong. Extra effort should be made in the initial phase of the project to assure that the flooring contractor will provide significant ventilation. Measures may include closing off the door louvers (and any other openings to the corridor) and installing fans in the exterior windows to exhaust the rooms. Fans should be more substantial than a house size window fan. It is important to identify these requirements in the specifications so that the issue is confronted early. Obviously, if the area is not on an exterior wall, other venting methods and after hours installation may be necessary.

   B. Please notify M.I.T. Safety Office prior to specifying or installing an epoxy terrazzo floor.

2. **Terrazzo Types:** There are many terrazzo types, thicknesses, and compositions. Use the "Terrazzo Information Guide, Design and Technical Data Book" available free from the National Terrazzo and Mosaic Association, Inc., Des Plains, Illinois [1-800-323-9736].

   A. Portland Cement-Type: This system is composed of 70% marble chips and 30% Portland Cement binder, usually white or gray. The marble is very low in porosity but the binder is not and must be protected with a penetrating solvent-type sealer immediately after the final polishing. The sealer will not produce a sheen. This final step is not usually provided by the installer unless specifically required in the specifications.

   B. Resinous Type (epoxy and polyester): The matrix in these systems is non-porous and therefore require no penetrating sealer. A surface sealer is required, however. This type of system is typically more resistant to harsh chemicals and can be applied in a thinner cross-section than standard terrazzo. This is the preferred M.I.T. system.

3. **Existing Conditions:** The Designer must confirm the stability of the existing substrate. In many areas, especially non slab-on-grade areas, the sub floor is often separated from the slab and must be removed and replaced prior to the terrazzo installation.

4. **Waterproofing Membranes:** Provide waterproofing membrane under the new terrazzo installation where the risk of damage to the floor or floors below is great. When installing an epoxy terrazzo floor over a slab on grade, confirm the existance of a vapor barrier under the slab.

5. **Final Cleaning:** Thoroughly clean terrazzo using Hillyard, Inc. "Super Shine All" cleaner and buff surfaces with a mechanical buffer mounted with a brown or red polishing pad. Obtain approval of cleaning and sealers to be used from M.I.T. Building Services Operations Manager prior to application of sealers.

   A. First Sealer: Hillyard Inc. "341" [Hillyard, Inc. 1-800-365-1555]. This requirement may vary, so obtain approval from M.I.T. Building Services Operations Manager prior to application of the sealer.

   B. Final Sealer: Hillyard Inc. "Odyssey" buffable wax [Hillyard, Inc. 1-800-365-1555]. This requirement may vary, so obtain approval from M.I.T. Building Services Operations Manager prior to application of the sealer.

END OF SECTION

SECTION 09510 - ACOUSTICAL CEILINGS

1. **Limitations:** Do not use concealed spline systems except in architecturally significant areas since these systems are difficult to remove and replace for above ceiling maintenance and access. Do not use ceiling tiles which are stapled to strapping or adhered in place, since these cannot be easily removed and replaced for maintenance. Installation of a concealed spline ceiling is subject to the approval of the M.I.T. Preventive Maintenance Office.

   A. Adhesives: If adhered tiles must be used, use non-flammable, non-combustible adhesives acceptable to M.I.T. Safety Office.

   B. Linear Metal Ceilings: The use of linear metal ceiling systems is discouraged since access above these ceilings is difficult and time consuming.

2. **Acoustical Ceiling Selection:** For work within an existing building, it is best to use the same ceiling tile used elsewhere in the building unless there is an overriding design concern. This permits M.I.T. to buy fewer types and styles of tiles.

   A. Consider Long Range Maintenance Issues: M.I.T. does not have storage space for maintenance stocks of ceiling tiles. Since acoustical ceilings always need repair and since repair material may need to be purchased many years after the ceiling is completed, the long term availability of the ceiling panel pattern should be checked. Use acoustical ceiling products which are not “trendy”, which are likely to be available far in the future, and which are common throughout the industry. Some acoustical ceilings M.I.T. is currently using are Armstrong Cirrus or Second Look series.

   B. Acoustics: The ceiling product Noise Reduction Coefficient should be considered when selecting acoustical ceiling products. When moving, vibrating, or noisy mechanical equipment is located above suspended acoustical ceilings, the acoustical ceiling alone is often inadequate and cannot provide an adequate sound environment in the office, lab, or classroom below. Additional acoustical insulation placed above the ceiling and other effective sound isolation and attenuating materials will likely be needed. Do not enclose noisy mechanical equipment above suspended ceilings with rigid assemblies, sheet lead, or other construction which restricts access to the equipment or which requires major demolition and reconstruction each time the equipment is serviced.

   C. Sensitive Locations: In clean rooms and other applications sensitive to airborne particulate, consider the use of “MSG” Clean Room ceiling, a plastic coated washable tile. “Normal” fiber based panels (such as Travertone fissured by Armstrong) can introduce unwanted particulate into the air.

3. **Earthquake Considerations:** Since unbraced acoustical ceilings can easily collapse during lateral earthquake loads, consider the importance of the occupancy when selecting the ceiling system. To resist lateral ceiling movement due to earthquake loads in important occupancies, specify cross-bracing of wire ceiling hangers at about 8 feet on center in both directions or resist lateral ceiling movement with adjacent walls or construction.

   A. Important Occupancies: Locations which may require special earthquake ceiling bracing include ceilings over hospital beds, ceilings in emergency control locations such as police station communication centers, and other areas where there is a major danger to life safety.

4. **Fire-Rated Ceilings:** When using fire-rated acoustical ceilings, remember that electrical and mechanical ceiling penetrations must be limited and constructed to comply with the requirements of the listed fire-rated assembly. Special coordination of the mechanical and electrical contract documents is required. This is commonly forgotten, resulting in Change Orders. Hold-down clips make access above the ceiling difficult and the clips may not be properly reinstalled.

5. **Asbestos:** Some existing ceilings may contain asbestos. Comply with the requirements of the IHO and EMS and Guidelines Section 02070 - Demolition.

END OF SECTION

SECTION 09550 - WOOD FLOORING

1. **Locations:** Wood flooring may be appropriate for gymnasiums, athletic floors, stages, dance floors, museums, and other special spaces. Refer to Appendix B for specific locations and requirements.

   A. Since wood floors require much more maintenance, use wood floors only where truly necessary and only where approved by M.I.T.'s Building Services Operations Manager.

2. **Safety Issues:** Please review wood flooring with M.I.T.'s Safety Office early in the design phase.

   A. The design and installation of wood flooring must comply with Massachusetts Building Code requirements, including requirements for firestopping of sleeper spaces, fuel loading [quantity of combustible materials used], and other issues. Sprinklers are typically required for large concealed spaces.

   B. Massachusetts Building Code [Fifth Edition] Section 924 applies for typical M.I.T. concrete buildings. Other Sections of the Code which should be reviewed are Table 401, Section 903, and Sections 402 and 403.

3. **Reference Standards:** Strictly comply with the recommendations and publications of the National Oak Flooring Manufacturer's Association and Maple Flooring Manufacturing Association.

4. **Vapor Barriers:** Effective vapor barriers are required under most wood floors. The referenced standards provide details and specifications for typical vapor barriers. Wood floors over slabs on grade, swimming pools, showers, and other wet and humid areas need special consideration.

5. **Contract Requirement Checklist:** The Contract Documents must clearly show the following:

   A. Wood species.
   B. Wood grade and cut. At stage floors, use only vertical grain wood.
   C. Wood width, thickness, and lengths.
   D. Type of vapor barrier.
   E. Type of subfloor construction including spacing of subfloor sleepers [if any].
   F. Method and spacing of fasteners.
   G. Type of finish, number of finish coats, degree of sanding and surface preparation needed. Use Hillyard "Trophy" finish for typical athletic wood floors.
   H. Extent, colors, and requirements for gamelines [applies to athletic floors].

END OF SECTION

SECTION 09650 - RESILIENT FLOORING AND BASE

1. **Extent of Resilient Flooring and Base:** Resilient flooring and base is acceptable for M.I.T. and Group Use areas and is discouraged in major Public circulation spaces and entrances. These spaces are defined in Appendix B.

2. **Wall Base:** Use either rubber or vinyl base. Use coved base at hard floors and straight base at carpet.

   A. Colors: Use dark colors only; M.I.T. Building Services has lots of problems with light colors.

   B. Height: 4" minimum preferred.

   C. Corners: Avoid the use of molded corners since they are manufactured separately from the base and often do not match in color or dye lot. Let wall base wrap outside corners, but ensure that seams are at least 12" from corners and farther if possible. Do not wrap inside corners; cut and cope base at inside corners.

3. **Vinyl Composition Tile:** Use 1/8" thick tile. Tile should have color all the way through the cross section, not just on the surface.

   A. Colors: Avoid use of solid color tile; use typical mottled blended color tile. Light colors are preferred. Avoid "fashionable, trendy" colors; use colors which will be available in the future. Solid color tiles tend to be less resistant to abrasion and will show wear quicker than a "mottled" tile. They are best used as borders and accents.

4. **Sheet Vinyl Flooring:** Sheet vinyl is not often used at M.I.T., but may be needed in clean rooms and similar areas. In areas that require sheet vinyl, the Designer should carefully consider the detail at the intersection of the wall base and the flooring. Often a continuous seal is required to limit spills or contamination from seeping into the crack between floor and base. An alternative is to use an integral cove base.

5. **Resilient Stair Flooring and Trim:** M.I.T. does not typically use resilient finishes in stairs. Stairs are often bare concrete. Stairs must have integral nosings which can take severe traffic and abuse.

6. **Raised Profile Flooring:** Raised profile flooring is difficult to clean and maintain, but it does have desirable slip-resistant characteristics since the profile pattern may channel water off the walking surface. If raised profile flooring is used, the pattern should be round dots and not squares, and the raised profile must be low with radiussed edges to permit maintenance. Raised profile flooring is often used in M.I.T. elevators and is good for unstable and moving subfloors such as old wooden subfloors since the large rubber tiles adapt to the irregular substrate better than smaller vinyl tiles.

7. **Installation Concerns:** Specify protection, cleaning, and waxing of resilient flooring as follows:

   A. Adhesives: Specify the adhesive to be used. For work in occupied areas, low odor adhesives are required. Non-flammable and non-combustible adhesives should be used. Contact the Manager of Building Maintenance, M.I.T. Safety Office, and M.I.T. EMS for additional advice.

   B. Protection: Immediately after installation, thoroughly sweep flooring and provide 100% coverage of heavy non-staining protective paper covering.

   C. Water: Do not wash or allow water to contact newly installed flooring until adhesive has fully cured [allow at least 4 full days].

D. Cleaning and Repair: Immediately before final acceptance or occupancy by M.I.T., thoroughly clean floors to remove all dirt, stains, and foreign substances. Remove and replace all damaged flooring including flooring with cigarette burns, chips, cracks, stains, and indentations.

E. Finishing and Waxing: Use finish and wax as directed by Building Service Operations Manager. Immediately before final acceptance or occupancy by M.I.T. and immediately after final cleaning, apply two full coats of floor finish to resilient flooring, resilient base, and resilient edge strips and trim. Polish between coats and mechanically buff after second coat to create a uniform clean luster.

END OF SECTION

SECTION 09680 - CARPETING

1. **Extent of Carpeting:** Use carpeting and carpet tile only when it is truly needed in the space and only where approved by the Director of Physical Plant and the M.I.T. Building Service Operations Manager. The use of carpet and carpet tile is discouraged because of significantly higher maintenance expenses associated with carpet. Refer to Appendix B for specific locations and requirements.

2. **Carpeting Prohibitions:** Do not use carpet or carpet tile in the following areas:

   A. Where food is served or eaten.

   B. In any basement or below grade level where dampness or water may be present [even rarely].

   C. Near any building entrance.

   D. In any major circulation areas, lobbies, corridors [Public areas as defined in Appendix B].

   E. In areas with wheeled traffic.

   F. Experimental laboratories.

3. **Carpet and Carpet Tile Procurement:** The following Guidelines apply:

   A. For space change projects, carpet and carpet tile will usually be furnished and installed by M.I.T. In that case, the Contract Documents should clearly state that carpet is N.I.C. [Not In Contract]. However, floor surface and substrate preparation to receive carpet is in the contract. The floor must be prepared by the General Contractor to the satisfaction of the carpet installer.

   B. For capital improvement projects, M.I.T. will usually purchase and furnish the carpet and carpet tile for installation by the Contractor.

4. **Emissions:** Specify carpet which has low indoor air pollution emissions, low overall VOC emissions, and low concentrations of toxic and irritating components. Require carpet manufacturers to provide this information and to certify that their carpets have low emission levels and are environmentally safe. A simple technique to evaluate carpet emissions is to place a representative sample of the carpet in a tightly sealed jar and let the jar sit in warm sunlight, then open the jar and sniff. Strong odors and chemical smell may give a clue that the carpet has excessive emissions requiring further investigation.

5. **Fire Performance:** Provide carpet which is fire-resistive or fire-retardant and which meets requirements of the State Building Code, fifth edition, Section 922.7.5.

6. **Broadloom Carpet Materials:** Bigelow "Stati-Tuff" is often used in dormitories, corridors, and general offices. Bigelow "Regent's Row" is often used in upgraded areas such as executive offices, lounges, and high traffic areas. Bigelow "Commitment" is often used in areas highly sensitive to static; this product has very low static propensity. Carpet should have at least the following characteristics:

   A. Fiber: 100% branded nylon [third or higher generation]. DuPont Antron or Monsanto, for example.

B. Pile Type: low pile, tufted level loop carpet with maximum pile height of 1/2" to allow for wheel-chair accessibility. Woven carpet will resist wear better over time and is preferred in high traffic areas such as classrooms, stairs, etc.

C. Face Weight: minimum 28 ounce face weight.

D. Density: At least 8 rows per inch length by 8 rows per inch width.

E. Backings: Provide jute or polypropylene primary and secondary backings.

F. Static Resistance: At least 3.5 KV resistance at 20% R.H. and 70°F; AATCC 134.

G. Mildew and Microbe Resistance: Treated with Dow “Sylgard” or equal. The treatment must be a permanent anti-microbial treatment.

7. **Carpet Tile Materials:** Carpet tile is not often used at M.I.T., but is sometimes used in high traffic areas such as libraries. When carpet tile has been required, Milliken Modular Carpet or Collins & Aikman carpet tiles have often been used.

8. **Maintenance Stock:** Specify at least 5% maintenance stock from the same dye lot as used on the project. In libraries and similar high traffic areas, specify at least 10% maintenance stock. For broadloom carpet, maintenance stock should be fresh, full roll width material and not scraps.

9. **Adhesives:** Specify the adhesive to be used. Use only stripable, water-resistant, non-flammable, non-combustible adhesives. For work in occupied areas, low odor adhesives are required. Contact the Manager of Building Maintenance, M.I.T. Safety Office, and M.I.T. EMS for additional advice. Use only adhesives that are specified by the carpet manufacturer for use with their product.

10. **Broadloom Carpet Installation:** Use only direct glue down installation. In general, do not use carpet pad or cushion [wet carpet cushion is a major problem at M.I.T.]. There are a few exceptions where carpet cushion is acceptable [example: the President’s House]. ADA requires a firm cushion, pad or backing, or none at all. Coordinate limitations of the accessibility requirements of the AAB and the ADA with backing and carpet installation.

11. **Carpet Tile Installation:** Use loose laid tiles with adhered grid of tiles at 10 feet on center as needed to control tile movement. Fully adhere tiles in very high traffic areas and where recommended by carpet tile manufacturer. Coordinate installation with type of carpet tile backing used; some backings require 100% adhesion.

12. **Shop Drawings Required:** Specify that carpet installation “shop drawings” be provided to show carpet layout, seams, and machine direction. In broadloom carpet, locate seams only in areas with low traffic and minimize the number of seams. Since all carpet has a machine direction due to the manufacturing process, show machine directions on shop drawings and run all carpet “grain” in the same direction. Show change of dye lot, if any.

END OF SECTION

SECTION 09700 - SEAMLESS FLOORING

1. **Extent of Seamless Flooring:** Seamless flooring and base is acceptable for M.I.T. and Group Use areas [as defined in Appendix B] and may be required in some laboratories, animal rooms, cage and glass washing areas, sterilizer rooms, and other wet areas where chemical and/or acid resistance are required.

2. **Preferred Systems:** Trowel on type, neoprene based seamless floors [Example: Dex-O-Tex "Neotex"] have been used successfully in animal housing rooms. Seamless epoxy based floor systems (such as Dex-O-Tex Cheminert "K") are also acceptable for areas that require chemical resistance.

   A. Occupied Areas: Many seamless flooring systems produce noxious odors and can even effect laboratory experiments which may be in progress in nearby areas. Before specifying a seamless floor system, verify the possible adverse impact on occupied areas. Consult Industrial Hygiene Office before specifying seamless floor systems.

3. **Waterproofing:** In wet areas, specify a waterproof membrane as part of the seamless floor assembly. These waterproof membranes are often needed, are considered optional by the flooring manufacturers and, if not specified in wet areas, will need to be added by Change Order. In renovations, installations over cracked slabs require waterproofing membranes.

   A. Waterproofing Details: Waterproofing is required at all slab penetrations to maintain the integrity of the "bathtub". All floor penetrations must be sleeved and the waterproofing turned up the sleeve and sealed to form a completely watertight assembly.

4. **Wall Base:** Seamless flooring systems should have integral wall bases to form a "bathtub". Consider the top of base termination detail and how the base stops at door frames and other locations.

5. **Acid Resistance:** The Designer should confirm the acid resistance qualities of the floor relative to the requirements of the space, especially in laboratories.

END OF SECTION

SECTION 09710 - EQUIPMENT ROOM FLOORING

1. **Classifications:** Mechanical, Electrical, and Transformer Equipment Rooms are classified at M.I.T. as Utility spaces which typically require only sealed bare concrete [see Appendix B].

   A. Preferred Sealer: Hillyard "Colortone #602" [Hillyard 1-800-365-1555]. See also Section 03345 - Concrete Sealing and Dustproofing. Sealers should be non-flammable and non-combustible.

2. **Waterproof Equipment Rooms:** For equipment rooms which are located adjacent to or over sensitive areas which could be damaged by leaking water, use a waterproof seamless floor such as Dex-O-Tex "M-E Flooring" or Neogard "Pedaguard". These flooring systems are expensive and should be used only where needed.

   A. Waterproofing Details: If a waterproofing system is used, waterproofing is required at all slab penetrations to create a "bathtub". All floor penetrations must be sleeved and the waterproofing turned up the sleeves and room walls, and sealed to form a completely watertight assembly.

END OF SECTION

SECTION 09900 - PAINTING

1. **Colors:** Never use light or pastel colors on doors, door frames, or other high traffic surfaces.

   A. Color Formulas: Specify that a detailed and precise color formula schedule is to be submitted for all colors used so that colors may be matched in the future.

   B. Corridors and Typical Interior Painting: Use "M.I.T. Off White" over M.I.T. Off-White primer. Under some conditions, the Painting Contractor may choose to purchase M.I.T. Off-white paint elsewhere, if so, the formula to match the color is:

      Pittsburgh Paint:
      1 gallon pastel tint white low-sheen base - 6-90
      1 tube C-10
      1 tube L-19

      1] For space change projects, the Contract Documents should require the Contractor to requisition the "M.I.T. Off White" paint for the finish coats from the M.I.T. Project Coordinator and the M.I.T. stock room [E19-111]. Specify that the Contractor is solely responsible for his quantity take-off, that the paint obtained by the Contractor is non-returnable to M.I.T., and that the Contractor will have the cost of the paint deducted from the Project Contract Amount by Change Order. For orders over 25 gallons, the Contractor must give the stock room at least two working days notice.

      2] For capital improvement projects, the Contractor will be given the "M.I.T. Off White" color formula and source, and should be required to obtain the paint without M.I.T.'s involvement.

   C. Handrail Systems: Use only dark glossy colors. The Designer may consider the use of contrasting colors to assist the visually impaired. However, the selection of colors should be reviewed with the M.I.T. project manager before the final specification.

   D. Accent Colors: One accent color may be used on one wall in a room; other walls should be "M.I.T. Off White". Trim may be an accent color.

   E. Tint Each Coat: Specify that each coat must be tinted a different shade so that the number of coats can easily be verified by scratch tests.

2. **Extent of Paint Work:** Paint all visible surfaces which are not prefinished including all mechanical and electrical elements in finished spaces, except do not paint sprinkler heads nor heat or smoke detectors.

   A. Identification System: Mechanical and electrical elements including fire alarm and sprinkler systems are identified by color code system. See Division 1 General Requirements and Division 15 and 16 guidelines.

3. **Paint Materials:** If there is a deviation from the M.I.T. standard paint, always specify the highest quality paint possible; when in doubt, contact the paint manufacturer and ask. There is a wide range of quality levels in the paint industry and nearly all paint manufacturers offer a range of qualities.

4. **Paint Schedule:** Specify one primer and two finish coats for each surface, except as noted.

Surface	Paint System
Painted Doors:	Full or semi-gloss alkyd.
Handrail Systems:	Full gloss alkyd.
Animal Rooms:	Full gloss alkyd, waterproof epoxy systems may be needed.
Glassware Washing Rooms:	Full gloss alkyd.
Sterilizer/Autoclave Rooms:	Full gloss alkyd.
Office Walls:	Eggshell latex alkyd system.
Classroom Walls:	Eggshell alkyd system.
Typical Lab Walls:	Eggshell alkyd system.
Corridor Walls:	Semi-gloss alkyd system.
Interior Masonry Walls:	Block filler and semi-gloss alkyd.
Interior Metal Doors/Frames:	Semi-gloss alkyd system.
Exterior Masonry	Elastomeric waterproofing paint [M.I.T. has successfully used Devoe “Renu-coat”]
Exterior Wood	Varnish; do not use oil finishes.
Interior Wood	Polyurethane; satin finish

5. **Variegated Coatings:** Variegated coatings such as Polomyx and Zolatone, which are often proposed because of their claimed maintenance capabilities, are not typically used at M.I.T. since the established system is based on M.I.T. “Off White” alkyd coatings. Where one of these systems is specified for an area, consideration must be given to when and how the area will be painted. Because of the nature of the application system, these finishes give off excessive odors. After hours spraying may be necessary. A shutdown of the HVAC system is also necessary to prevent distribution of the odors. Consider the use of a water-based system which is relatively odorless and much less toxic. This product is being successfully used in health care applications around Massachusetts.

6. **Lead Paint:** For renovation work, existing surfaces may need to be tested for lead paint. Lead paint must be removed from areas occupied by children and families.

7. **Spray Painting:** Require the Contractor to review procedures with the M.I.T. Safety Office before spraying any flammable materials.

END OF SECTION

DIVISION 10 - Specialties

Table of Contents

SECTION 10100 - CHALKBOARDS AND TACKBOARDS

1. **Chalkboards:** Typically use porcelain on steel chalkboards with 25 year warranty on writing performance.

   A. Chalkboard Color: In general, black is the standard color although other colors have been used to accommodate the requests of certain users.

   B. Chalkboard Trim and Accessories: Chalkboards should be furnished with tackable map rails and map hooks at top of chalkboard, and a continuous chalk tray rail. The chalk tray rail may be detachable.

   C. Chalkboard Noise: Building occupants make numerous complaints about noise transmission through chalkboards to adjacent rooms [typically, the noise of chalk against the chalkboard]. The Designer should make investigations and determine how this problem can be best resolved. An ideal solution is to locate chalkboards on corridor walls or walls which are not shared by other occupants. A layer of cork or other resilient sound absorbing material placed between the chalkboard and the wall may help when the chalkboard must be located on a shared wall.

   D. Electric Chalkboards: Do not use electrically operable chalkboards where there is a space or cavity above since an electrically started fire would not be contained.

2. **Markerboards:** Although markerboards [whiteboards] may be requested by some faculty members, the use of markerboards should be discouraged.

   A. Markerboards are often stained when standard markers are used and many users do not understand that special markers are needed.

   B. Building Services has significant problems cleaning markerboards since special solvents are often needed and since cleaning often takes much longer than normal chalkboards.

   C. When used, markerboards should have a matte finish to reduce glare and increase visibility; unfortunately, the matte finish makes the markerboards easier to stain and more difficult to clean.

   D. Markerboards should be fabricated from 3 coat porcelain on 24 gage steel; do not use white melamine since this type of markerboard stains easily. Provide minimum 1/2" thick particleboard core with 0.015" thick aluminum foil backer sheet. 24 gage steel marker boards may be subject to minimum order limitations. In such cases, 28 gage is acceptable.

3. **Tackboards:** In public areas such as corridors, use non-combustible, burlap backed “Forbo Bulletin Board Cork Linoleum” Forbo Floor Coverings, Inc., Richmond, Virginia 1-800-233-0475 [used in Main Group corridors].

   A. Fabric covered tackboards are not desirable in public areas, but may be used in more controlled spaces such as offices.

4. **Frames for Chalkboards, Markerboards, and Tackboards:** Standard extruded aluminum and wood frames are acceptable.

5. **Glass Enclosed Bulletin Boards:** Glass enclosed tackboards and display cases are appropriate where control is required. Provide a locking glass door of tempered or laminated safety glass. Display cases in corridors must meet the requirements of the ADAAG Section 4.4.1 for protruding objects. Sliding doors are recommended rather than swinging doors. Planning Office approval is necessary before installation in the Infinite or other highly used corridors in the Main Group.

END OF SECTION

SECTION 10160 - TOILET PARTITIONS

1. **Toilet Partition Mounting:** To the greatest extent possible, use ceiling hung partitions. Floor mounted partitions are not preferred since they make floor cleaning difficult. In some locations with very high ceilings [such as the Main Group buildings] floor mounted partitions with overhead bracing may be unavoidable.

   A. Clearly show and specify concealed framing above ceilings for ceiling hung partitions.

   B. In all types specify that the gap between partitions and walls and between adjoining partitions does not exceed 1/2". Larger gaps allow unrestricted sight into the stall.

2. **Toilet Partition Materials:** The most durable materials are preferred. The material used should be selected for the type of use expected; toilet rooms that get abuse need better materials. Light colors are preferred because of their inherent resistance to showing wear and marks.

   A. Baked Enamel Steel: Baked enamel steel partitions are commonly used at M.I.T. They are economical and can be refinished easily. It is likely that they will corrode and loosen at the fittings. At areas which receive abuse, a more durable partition is preferred.

   B. Separate “Rooms”: Some high traffic toilet rooms in newer McDonald’s restaurants use drywall partitions with ceramic tile, hollow metal frames [stopped well above the floor], flush solid core wood doors [with height similar to typical toilet partition doors], and stainless steel door hardware. This toilet partition assembly is highly durable and abuse resistant, and similar to high traffic public toilets often found in Europe. Building Services believes these could be cleaned reasonably easily. This solution should be considered for areas which receive abuse.

   C. Stone: Stone partitions [including man-made stone-like products such as DuPont “Corian”] with stainless steel fittings are durable. Porous stone should be sealed to reduce staining and absorption. Stone partitions have high initial cost and are unlikely to be used at M.I.T.

   D. Millwork: Custom wooden partitions with a polyurethane finish on the wood and with stainless steel fittings and hardware can be durable and attractive. Due to the high initial cost, this solution is unlikely to be used at M.I.T.

   E. Glass: Opaque and translucent patterned glass partitions are highly resistant to minor surface damage and water damage. Glass partitions must be safety glass and engineered to withstand severe impact without breakage. Glass partitions will be heavy and require special attention to fittings and connections. Due to the high initial cost and the possibility of breakage, this solution is unlikely to be used at M.I.T.

   F. Stainless Steel: Stainless steel partitions may have problems with denting and will loosen at the fittings, but may be a good choice for very wet areas.

   G. Porcelain Steel: Porcelain on steel has a fused glass-like finish and is hard and durable, but also difficult to touch-up and repair. These are more expensive than baked enamel partitions and M.I.T.’s experience has been that the additional initial cost is not justified.

   H. Plastic Laminate: The surface of plastic laminate partitions can be easily damaged and cannot easily be repaired. Plastic laminate partitions are heavy and require extra attention at the fittings and connections. Plastic laminate partitions can delaminate and the particleboard core can swell if the panels get too wet. Adhesives used must be non-flammable or have high flash points. Plastic laminate partitions are not recommended for M.I.T.

I. Solid Plastic: Solid plastic partitions are highly resistant to water damage and may be a good choice for shower partitions. The surface can be scratched and gouged easily, and repair is difficult.

END OF SECTION

SECTION 10200 - EXTERIOR LOUVERS

1. **Exterior Louvers:** Exterior louvers are typically used for air intakes, exhausts, and ventilation of equipment spaces.

2. **Coordination:** Specify exterior louvers under Division 10 and not in Division 15 - Mechanical to give the Architect control of the louver appearance and finish [mechanical engineers may be more interested in the louver's performance and not appearance]. Coordination between the Architect and Engineer is required to ensure that appearance, finish, and performance requirements are satisfied, and to ensure that the louvers are not specified in two places [Division 10 and Division 15].

    A. Louver Performance Requirements: Louver performance such as free area, air resistance, zero water infiltration air velocity, and other characteristics must be specified in coordination with the Mechanical Engineer.

3. **Louver Materials:** Extruded aluminum and roll formed steel are the most common louver materials. The Designer should indicate which material is required for the project.

4. **Louver Blade Styles:** Louver blades can be obtained in many styles and profiles, each having different appearance and performance. For air intake louvers, louvers should be selected to prevent snow from being sucked into the building.

    A. Louver blades are typically arranged to shed rain water and to control vision through the louver from some viewing angles. Consider the most likely viewing angle of the louvers and determine if vision through the louver will be a problem.

5. **Louver Locations:** Where possible, louver sills should not be within 24" of any horizontal surface [grade, paving, roofs] since snow can drift and build-up in these corners and possibly block the bottom of the louver. Louvers should not be near building entrances, major exterior walks, nor outdoor sitting and lounge areas. Air intake louvers must not be located near loading docks, trash dumpsters, or vehicular parking areas.

6. **Louver Finishes:** Clear anodized aluminum and color anodized aluminum should be Class 1 [at least 0.7 mils thick]. Some manufacturers offer Class 2 [0.4 mils thick] which is generally accepted for interior work only. Kynar 500™ based paint is the best choice for painted finishes; baked enamel paint finishes are cheaper, but should be avoided since there are problems with long term color retention and paint film performance.

7. **Protection:** Effectively protect special finishes before, during and after installation.

END OF SECTION

SECTION 10410 - BUILDING DIRECTORIES

1. **Directory Procurement:** M.I.T. will furnish and install directories. The Contract Documents should include concealed blocking and supports for directories.

2. **Directory Locations:** M.I.T. buildings typically require a building directory at major building entrances and lobbies, and at upper elevator lobbies [floor directories]. Floor directories typically show room numbers but do not list names. Floor directories should be oriented in the same compass direction as their viewer.

   A. Coordinate directories with building evacuation signs and Emergency Action Floor Plans [there is a suggested standard Emergency Action Floor Plan key available from the Safety Office].

3. **Directory Types:** Two types are commonly used. The department or user often has input into the type of directory used.

   A. Lockable cases with safety glass fronts and changeable letters.

   B. Plastic plaques with changeable plaque inserts.

4. **Graphics:** Simple changeable letters and engraved plastic stock are preferred over film negative directories or other directories which would require special ordering of name strips.

   A. Plans: Directories often include building floor plans to help orient user and to assist persons with disabilities regarding routes of egress and access

5. **Color Code:** Floor plans may be color coded to indicate the floor as follows:

Floor	Color	Pantone Number
Sub-Basement	Red	186
Basements and Street Level	Red	186
Second Floor	Green	348
Third Floor	Blue	299
Fourth Floor	Orange	021
Fifth Floor	Brown	160
Sixth Floor	Purple	228

   For higher floors, the color scheme repeats.

   A. Pantone numbers are for general guidance for color. The Pantone color will not match the actual colors perfectly.

6. **Keys:** Keys for locking directories should be given to the user department head so they can open and change their own directory without assistance from Physical Plant. A second set of keys must be furnished to the M.I.T. Key Controller.

END OF SECTION

SECTION 10440 - SIGNS AND GRAPHICS

1. **Sign Procurement:** Signage will typically be furnished and installed by M.I.T. Contract Documents should include concealed blocking, built-in supports, and rough-in for major signs.

2. **Sign and Graphics Locations:** The following checklist is intended to serve as a reminder:

   A. Exterior building signs stating the building name and number are needed at all major building entrances. Requires coordination with Planning Office and Grounds Department.

   B. Exterior signs instructing truck drivers may be needed a loading docks and loading areas. “Turn off engine” signs are required. Requires coordination with Planning Office, Grounds Department, and Campus Police.

   C. Exterior barrier-free pathway and entrance signs may be needed to direct people to barrier-free entrances, if the entrance location is not obvious. Requires coordination with Planning Office and Grounds Department.

   D. Exterior clearance signs are needed at overhead doors, garages, vehicular entrances, and at overpasses and bridges. Requires coordination with Physical Plant Department.

   E. Exterior vehicular traffic signs may be needed to control parking and loading zones. Requires coordination with Planning Office, Grounds Department, and Campus Police.

   F. Exterior signs are needed at fire lanes. Requires coordination with Planning Office, Grounds Department, Safety Office, and Campus Police.

   G. Interior signs are needed on all rooms identifying the building and room [example: E18-207]. These signs are needed for maintenance and key control. Requires coordination with Physical Plant Department.

   H. Interior signs at elevators are required by code to warn against the use of elevators during fires. These are often integrated with the elevator call buttons. Requires coordination with Physical Plant Department and Safety Office.

   I. Interior signs are needed at egress routes and egress stair doors. Requires coordination with Physical Plant Department and Safety Office.

   J. Interior signs are needed on all toilet rooms identifying “Men” and “Women”. Requires coordination with Physical Plant Department.

   K. Interior floor directory signs are needed near elevator lobbies, building intersections and major public circulation stairs to show location of room numbers in the building [example: Rooms 201-210>, Rooms 210-220<]. Requires coordination with Physical Plant Department. This is also discussed in Section 10410.

   L. Interior signs for department or group suites are not wanted since building occupants move too quickly, unless the department will agree to pay for the signs. There are many exceptions to this situation and each case must be reviewed individually.

3. **Graphic Standard:** Room numbers require barrier-free raised letters and numbers with Braille mounted on mechanically fastened plastic plaques. The two systems in place at M.I.T. are:

   A. Main Group: The signs for the Main Group Buildings are 1 1/4" x 4" with room numbers only.

   B. All other buildings have 5" x 5" signs with room number and index card holder.

   C. Informational Signs: The size of the sign and lettering should be related to the size and importance of the message or space identified and in accordance with the requirements of the ADA and AAB.

   D. Sign Mounting Heights and Locations: Comply with 521 CMR Architectural Barriers Board and the requirements of ADA . At all non-accessible public toilet rooms, provide sign directing to location of nearest accessible public toilet room. At all non-accessible public building entrances, provide sign directing to location of nearest accessible building entrance.

   E. Signs In Means of Egress: Provide raised tactile signs and graphics to comply with 521 CMR Architectural Access Board and ADA.

   F. At shops and industrial applications, comply with OSHA 1910.145 and ANSI Z35.1-1972. A copy of these standards is available for review in the Safety Office.

END OF SECTION

SECTION 10500 - LOCKERS

1. **Lockers:** The following is a checklist of common locker requirements:

   A. Building Services Locker Room: 12"w x 18"d x 72"h, two per person: one locker is needed for personal belongings [with no management access] and one for building services supplies [with management access].

   B. Lockers are typically needed for animal facility staff, health services, building matrons, campus police, lab personnel, at athletic facilities, and other users.

   C. Locker Size: 12"w x 18"d x 72"h is typical. For police and personnel with neatly pressed uniforms, 21" deep or deeper lockers are probably needed to permit proper clothes hanging.

2. **Locker Types:** Solid wall wardrobe lockers with vents are typically used, although open [mesh or stamped diamond pattern] athletic type lockers should be considered for improved ventilation.

   A. Tops: Lockers which are not recessed into walls should have heavy-gage sloping tops.

3. **Locker Locks:** Typically, a combination padlock will used. Padlocks may be furnished by M.I.T.

4. **Locker Bases:** Concrete platforms with resilient base are preferred for most permanent applications and required in wet areas. Metal locker bases are too easily damaged and are discouraged. Wooden platforms are sometimes used in renovation work and for temporary installations. Wooden bases should not be used in wet areas.

5. **Locker Benches:** Benches should be located directly in front of lockers, where possible. Benches must be capable of supporting 100 pounds per linear foot live load. Bench pedestals and supports should be designed to permit simple floor cleaning. Wall mounted benches are preferred over floor mounted benches, where possible. Metal bench supports at the floor should be highly water and corrosion resistant. Movable benches may be used where appropriate.

END OF SECTION

SECTION 10520 - FIRE EXTINGUISHERS AND CABINETS

1. **Extinguisher and Cabinet Extent and Locations:** Generally, comply with NFPA 10 Portable Fire Extinguishers [copy is available for review in the Safety Office] and obtain approval from M.I.T. Safety Office.

   A. Conform to NFPA 14 for piping and labeling of fire hose cabinets. Coordinate all requirements with the Cambridge Fire Department and M.I.T. Safety Office.

2. **Travel Distances:** NFPA 10 includes tables [3-2.1 and 3-3.1 in 1988 Edition] of maximum travel distances to extinguishers which must be used to determine extinguisher spacing and locations. Maximum travel distances typically range from 30 feet to 75 feet depending on the type of Hazard Occupancy and type and size of extinguisher.

3. **Floor Area Per Extinguisher:** NFPA 10 includes tables of maximum floor areas per each extinguisher [Table E-3-4 in 1988 Edition]. For example, a typical 4-A rated extinguisher can cover 6,000 square feet in Ordinary Hazard Occupancy.

4. **Extinguisher Types:** There are several different types of extinguishers commonly used. NFPA 10 lists the advantages and common uses of each type. Halon extinguishers [type 1211 or 1301] are not permitted at M.I.T. The M.I.T. Safety Office should be consulted about specific applications.

5. **Extinguisher Containers:** Use red enameled steel cylinders, except use stainless steel cylinders for water extinguishers, and use aluminum cylinders in locations where steel could rust. Aluminum cylinders must be approved by Safety Office.

6. **Cabinet Types:** Use fully recessed cabinets in corridors and public areas. Fully recessed cabinets will typically require a thick wall, so the cabinets are often placed near corners and columns so the cabinet can be boxed in or enclosed.

   A. Lock/Latch: Use roller catches. Do not use locks or latches which require breaking glass or other special access.

7. **Extinguisher Identification:** Provide signs and identification to comply with 527 CMR 10.02 [copy available for review in Safety Office]. Location Plan for portable fire extinguishers should be approved by the Safety Office.

8. **Plywood Mounting Boards for Wall Mounted Extinguishers:** Are typically not used at M.I.T. When used, they are often painted to match adjacent walls; bright red boards are not required.

9. **Specification Check:** Check that all extinguishers are specified to be provided filled, charged, tagged, dated, and ready for immediate use. This will help reduce change orders.

END OF SECTION

SECTION 10560 - MAILBOXES

1. **Incoming Mail:** Mail sent to the M.I.T. community.

   A. Mail Distribution: Generally, M.I.T.'s Building Services Department will pick-up (or have delivered) mail in bulk at the Post Office and distribute mail on campus. Some buildings have municipal addresses and receive incoming mail from off-campus directly from the Post Office [often residence buildings].

   B. The M.I.T. Project Manager must first confirm with the Building Services Manager whether the Project will receive mail delivery service from the USPS [United States Postal Service] or from M.I.T. Building Services. In addition to incoming off-campus mail, all buildings will receive on-campus mail from M.I.T. Building Services.

   C. Mail Boxes to Receive USPS Mail Delivery Service: Mailboxes are generally required for buildings to which the USPS will deliver mail. The intent is for the USPS letter carrier to place the mail into individual boxes typically located in or near the main building lobby; this will save M.I.T. the expense of sorting and delivering mail to building occupants. All mailboxes to which the USPS delivers mail must be USPS approved [manufacturer's catalogs usually indicate the USPS approved versions]. Please remember that buildings which receive USPS off-campus mail service will also receive M.I.T. Building Services on-campus mail service. The USPS typically prohibits the use of one mailbox for both USPS and private mail systems, so two boxes or a partitioned mailbox is usually required.

   D. M.I.T. Building Services Mail Delivery Service: For buildings receiving both off-campus and on-campus mail from M.I.T. Building Services, a mail room to store and sort mail is required [see Appendix A]. Mailboxes should be provided [loaded from the controlled mail room side with mail taken from the public side] so M.I.T. Building Services does not have to deliver mail to each floor and office. Mailboxes which are not used by the USPS do not need to be USPS approved. Since many existing buildings do not have proper mail rooms or central mailboxes, M.I.T. Building Services does deliver mail to floors and offices, but this procedure is inefficient and time consuming, and should be avoided where possible.

   E. Mailbox Locks: USPS mailboxes use USPS locks. M.I.T. mailboxes use S-25 key locks. Locks will be keyed by M.I.T. locksmith.

2. **Out-Going Mail:** Mail going off-campus will be deposited in USPS Mail Boxes typically located outside of buildings on sidewalks and public ways; the Postmaster determines where USPS drop-off mailboxes will be located. Building mail rooms should have a drop-slot for on-campus mail so that Building Services does not have to go to each Department Office to pick-up mail. For buildings without proper mail rooms, Building Services will pick-up mail at Departmental Offices.

3. **Mail Room Requirements in Appendix A:** See Appendix A for program requirements for typical mail rooms.

END OF SECTION

SECTION 10650 - OPERABLE PARTITIONS

1. **Operable Partitions:** Operable partitions are often used to create multi-use flexible size spaces. Accordion type operable partitions are not acceptable for this application.

   A. Egress: The Designer must carefully evaluate egress and determine if exit doors are needed within the operable partition.

2. **Acoustics:** The highest initial acoustical performance is generally preferred to permit some performance degradation as the panel seals wear out.

   A. Sound transmission above and around operable partitions must be addressed by the Designer. Sheet lead drapes, acoustical insulation, framed walls, and other materials are probably needed to create effective acoustical barriers above operable partitions and ceilings.

3. **Coordination:** Operable partitions typically require miscellaneous metal framing and supports concealed above ceilings to support the head track. More often than not the head track will require structural support that will necessitate the services of a licensed structural engineer. Detail and specify the required concealed framing to reduce Change Orders. Floor tracks may also be needed and should be detailed to prevent tripping hazards.

4. **Panel Finishes and Foam:** Fabric covered partition panels are typically used. Painted steel panel finishes may be more durable, but they may cause decreased acoustical performance. Panel finishes and foam must comply with Massachusetts State Building Code, Article 900, and 527 CMR 21.00 for fire performance characteristics. Fire-retardant acoustical partitions are required.

5. **Chalkboards:** Avoid placing chalkboards on operable partitions, since noise transmission of chalk hitting the board is likely to be objectionable in the adjacent space. See Section 10100.

6. **Electrical Wiring:** All partitions with interior electrical wiring must be reviewed and approved by M.I.T.'s electrical shop.

7. **Glass:** All glass in operable partitions must be safety glass.

8. **Stability:** All operable partitions must be stable assemblies and not easily knocked over or displaced.

END OF SECTION

SECTION 10800 - TOILET ACCESSORIES

1. **Scope:** Toilet Accessories furnished and installed by M.I.T.:

   A. Loose, floor mounted waste receptacles. Since floor mounted waste receptacles can more easily corrode and can interfere with floor cleaning, the Designer should investigate using a large capacity [minimum 18" x 18" x 23"] wall supported waste receptacle.

   B. Shower curtains and curtain hooks.

   C. In some high volume locations, M.I.T. may subcontract for the furnishing and maintenance of Sanitary Napkin/Tampon Vendors.

2. **Toilet Accessories typically furnished by M.I.T. and installed by Contractor:**

   A. Paper Hand Towel Dispensers: Fort Howard Paper Company, Model 596-01; dispenses Fort Howard #224 Trump Plyfold Towels.

   B. Toilet Tissue Dispensers: Bobrick Model B-288 brushed stainless steel double-serve ; dispenses one ply, 4.5" x 4.5" tissues, 1000 sheets, 140.6 square feet per roll. Set at 24" a.f.f. (accessible stalls) .

   C. Soap Dispensers: Currently, Hospec 6-B6 dispensers are being provided by M.I.T. , although several other types may be used depending on use and location; the Building Services Manager must be consulted for advice on type to be used. Large capacity dispensers must be used so dispenser only needs refilling once per day. The Designer must show one dispenser per sink and provide *minimum* 4" clearance from filler top to underside of any obstruction so dispenser can be re-filled from the top.

3. **Toilet Accessories Furnished and Installed by Contractor** (these must be approved by the Building Operations Services Manager):

   A. Semi-Recessed or Wall Supported Waste Receptacles: Provide off-the-floor stainless steel units with removable vinyl liners. To the greatest extent possible, provide semi-recessed type with key required for removal. A custom stainless steel wall mounting bracket may be needed. Large capacity [minimum 18" x 18" x 23"] waste receptacles are required since they will likely be emptied only once per day. The receptor opening should be large to prevent to opening from clogging and making the receptacle appear full. Small capacity waste receptacles with small openings and closing doors are practically useless at M.I.T. Examples: B-275 (surface - large), B-277 (surface - in single use locations), B-3947 (recessed, large dispenser /receptacle).

   B. Grab Bars for persons with disabilities: Comply with Building Codes and requirements of authorities having jurisdiction. Provide concealed mounting with Allen head set screw attached cap trims to conceal main anchors. Example - B-550. Set at 33-36" aff.

   C. Wall Mirrors: Either framed or frameless mirrors may be used. Framed mirrors are significantly more expensive, but usually have backing sheets which protect the mirror from premature deterioration. Unframed mirrors are much less expensive and easily replaceable. Unframed mirrors need ventilation behind the mirror to prevent spoiling. To prevent spoiling, unframed mirrors must never rest on countertops or on the tops of backsplashes and the bottom must not be sealed.

1] Mirror Placement: Mirrors must be placed with bottom of mirror height at <38" and accessible to people in wheelchairs. Full height mirrors [large vertical mirrors] are preferred to smaller mirrors and should not be placed adjacent to doors or in locations where they could be easily broken such as impact by wheelchairs.

D. Stainless Steel Shelves: A 6" wide shelf is a good idea to provide a place for purses, books, and other carried items. The shelf should be above or adjacent to lavatory sinks. The shelf *must* be at least 4" clear of the top of the soap dispenser for refilling of soap dispensers. Example B-296.

E. Sanitary Napkin/Tampon Vendors: Ginsburgh J-6 or Bobrick B-2800 (surface), B-3500 (recessed), keyed to the Chicago Lock Company CR-1 and CR-21 keying system. The amount to be charged by the vending mechanism should be reviewed with the Building Services Manager. Currently, the amount is 10¢._ In some high volume locations, M.I.T. may subcontract the furnishing and maintenance of Sanitary Napkin/Tampon Vendors.

F. Sanitary Napkin Disposals: Provide one for each women's toilet stall or a shared through-wall type. Disposals must be off the floor and should be recessed where possible. Bobrick B270 (surface), B4353/B4354-double (recessed). Locate between toilet and stall door on side opposite door hinge to avoid crowding toilet or interfering with door swing.

G. Shower Rods: Extra heavy duty, minimum 1-1/4" diameter, 18 gage stainless steel with concealed anchors.

H. Shower Soap Dish: Use stainless steel only; do not use ceramic since ceramic dishes are more easily broken. Do not thinset soap dishes; provide heavy mechanical lug mounting with fully grouted placement. The fasteners should be stainless steel also. The grout is porous and contains lime which can cause rusting of inferior metals which will discolor the tile and grout.

I. Towel Bar: Towel bars are not often used at M.I.T. When used, consider the use of handicapped grab bars for additional abuse resistance and safety.

J. Coat/Clothes Hook: Provide concealed anchorage and provide hooks capable of supporting at least 75 pound load with no damage. Example B-2116 for stalls.

4. **Accessibility:** The Designer should review the location of all toilet accessories for compliance with the ADA and AAB as well as coordination with other accessories and elements in the toilet rooms.

END OF SECTION

DIVISION 11 - Equipment

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SECTION 11010 - WINDOW WASHING SYSTEMS

1. **Window Washing:** Discuss window washing early in Design Development. Window washing is often forgotten during design causing problems and expense.

Δ A. M.I.T. uses an outside window washing contractor. Contracts are bid on an annual basis. The Designer should consult with the Building Services Manager for instructions prior to specifying.

B. Windows in academic buildings at M.I.T. are typically washed only once every two years, although some windows related to commencement are washed annually before commencement. Designers should avoid creating any condition which causes windows to get unusually dirty or stained.

2. **Window Washing Methods:** The method to be used to wash windows varies with each building, but generally falls into one of the following categories:

A. Operable Windows: Cleaning will be done from interior through open window. Safety belt hooks are required at interior window jambs. Avoid blocking windows with fixed furnishings and unit ventilators.

B. One and Two Story Buildings: Cleaning will be done from the ground using long handle poles and power lift platforms. Provide clear, unobstructed access at ground level to permit window cleaning.

C. Taller Buildings and Fixed Windows: Cleaning will be done from the roof with use of swing stages, baskets, and bosun's chairs. Bosun's chairs are most often used at M.I.T.

D. The Designer should plan carefully, in conjunction with Building Services, what methods will be used to clean windows in crossovers, bridges and elevated ramps.

3. **Window Washing from the Roof:** For window cleaning performed from the roof, the following issues must be considered during design:

A. Avoid deeply recessed windows and building overhangs since swing stage or bosun's chair may be too far from windows.

B. When swing stages are anticipated, provide davit sockets on roof to accommodate portable davits. Davit sockets must be spaced about 20'-30' on center, must be engineered to support the intended loads, and must be properly detailed and flashed into the roof system.

C. Provide life-line anchor eyes attached to roof structure. Window washers wear safety belts which are attached to a safety line which is attached to the building. If the stage or chair falls, the window washer will be held by the individual life line. Life-line anchors must be spaced about 20'-30' on center, must be engineered to support the intended loads, and must be properly detailed and flashed into the roof system. Life-line anchors may be attached to davit socket bases.

D. Window washing from the roof requires roof traffic on the roof and sometimes requires movement of davits and stages on the roof. For this reason, a continuous maintenance path must be provided along each roof edge and parapet from which window washing is to be done, especially when swing stages are used. Minimum path width of 4 feet is required. Path should ideally be made from 16" maximum square precast concrete pavers set over protection board. Pavers must be coordinated with roof drainage and the pavers must be properly specified to resist cracking and freeze-thaw deterioration.

E. Window washing with swing stages, baskets, and bosun's chairs often requires clear, unobstructed working space at ground level.

END OF SECTION

SECTION 11130 - PROJECTION SCREENS
(New Section)

1. **General:** The following information applies to front screen installations. Planning a new screen installation involves additional considerations, such as the audience seating patterns, projection equipment, ambient light, and the projection area. In many M.I.T. installations, an AV consultant is recommended.

2. **Screen Width:** The following are rules of thumb to be applied when considering the selection of a projection screen:

   A. Screen width should equal the distance from the screen to the first row of seats, divided by 2.

   B. Screen width should equal the distance from the screen to the last row of seats, divided by 6.

   C. For multi-image projection, double or triple the width derived above, according to the number of side-by-side images.

3. **Screen Height:** As a rule of thumb, screen height should equal or exceed the distance from the screen to the last row of seats, divided by 8. However, ceiling height and aspect ratio considerations may overrule this standard.

   A. Ceiling Height: The bottom of the screen should be at least 48" above the floor to allow all members of the audience to see. Thus, ceiling height may limit screen height.

   B. Aspect Ratio (relationship of height to width): Commonly used projection formats vary in aspect ratio from 1:1 to 1:1.5. If only one projection format will be used, screen height may be based on its aspect ratio. If more than one format will be used, screen aspect ratio must be adjusted accordingly.

   C. For multi-image projection, the screen should be sized to accommodate all of the images without overlap. If slides are included, both vertical and horizontal format should be accommodated.

4. **Considerations for Surface Selection:** The following should be considered when selecting the surface of the viewing screen:

   A. Viewing Cone of the audience

   B. Projection method: M.I.T. often utilizes special data or CRT projection devices that require a “Tab Tension Screen” to hold the screen flat.

   C. Image clarity vs. brilliance

   D. Location and abuse: If the screen is likely to be affected by smoke, fingerprints, dust, etc., then a special finish may be necessary.

   E. In some instances, a black out band is required at the top of the screen to shield out identity strips from certain types of films.

   F. When the major type of projection is to be from overhead projectors, the Designer should consider locating the screen farther from the wall to allow the screen to be tilted to accommodate “keystoning” of the image.

5. **Motorized Projection Screens:**

   A. Maintenance: M.I.T. prefers manual projection screens where ever possible. However, when it is necessary to specify an electrically operated screen, the Designer should consider how the motor will be accessed for maintenance and/or replacement.

   B. When electric screens are required, they shall be provided with a manual override to allow the screen to be maneuvered by hand.

   C. Manufacturer: Select a manufacturer whose product has a proven track record for quality and low maintenance.

END OF SECTION

SECTION 11150 - PARKING CONTROL EQUIPMENT

1. **General:** Parking control systems are typically governed by M.I.T. Campus Police who must be contacted to verify type of parking control required for the project. The M.I.T. Planning Office should also be consulted early in the design process.

2. **Typical Parking Control at M.I.T.:** M.I.T. most often uses a manned booth to restrict and control parking, although some automated control systems are used on campus.

   A. Attendant's Booth: For major parking lots and parking garages where M.I.T. wants an attendant on duty, provide a modular parking attendant's booth. The booth should be insulated and heated to at least 70°F; have lighting placed over the work counter; have power for cash registers, radios, and parking control system components; and have a telephone with restricted communication or other security communication. The attendant should be able to reach and communicate both entering and exiting vehicles from the booth windows. The ADA requires that new booths be made so that a person in a wheelchair can approach, enter and exit the booth. Substantial alterations of existing booths may trigger similar requirements. Typically, M.I.T. maintains one fully accessible booth on campus. Because this requirement may affect the design of the opening in a garage or lot, early design consideration is critical.

   B. The Designer should provide protection for the attendant's booth against collision from automobiles entering and exiting the lot or garage. The Designer may choose to use curbs, concrete filled steel pipe bollards or an equivalent means of protection depending on the area and surrounding conditions. Refer to Sections 02800 and 05500.

   C. Automatic Control Systems: There are no guidelines for automatic control systems at M.I.T. When used, the Contract Documents must at least clearly show: locations of card readers, gate operators, and control system; electrical conduits for both power and control wiring; protection bollards to protect card readers and gate operators from vehicular impact; and curbs and concrete platforms onto which parking control system components will be mounted.

END OF SECTION

SECTION 11160 - LOADING DOCK EQUIPMENT

1. **General:** Loading dock equipment must be provided to accommodate the type of truck and cargo expected. Some docks may need to accommodate large tractor trailers and others may need to accommodate small parcel vans [like UPS or Federal Express trucks].

   A. Different types of trucks have different load bed heights. Fixed loading docks should be at a height to closely match the load bed height of the commonly expected truck. Adjustable dock levelers can be used to accommodate a range of truck heights.

2. **Loading Dock Equipment:**

   A. Dock Bumpers: All loading docks should have dock bumpers to cushion the impact of the truck against the dock. The bumper height, width, thickness, type, and mounting location must be clearly indicated. Use industrial quality bumpers made from recycled truck tires.

   B. Dock Edge Angles: Concrete loading docks typically need a steel angle cast into the dock edge to protect the concrete from impact and damage. The edge angle should be hot dip galvanized structural steel angles with welded anchor lugs. This item is also discussed in Section 05500 - Miscellaneous Metals.

   C. Dock Levelers: Dock levelers are basically adjustable ramps which should be used at loading docks where several different types of trucks are expected. The dock leveler size, capacity, and type of mechanism must be specified. Every possible safety device and safety option should be required and specified. Key operated mechanisms are required to control and restrict operation.

   D. Dock and Material Lifts: Dock lifts are typically vertically moving platforms which can be raised and lowered to match the height of a truck, a dock, or grade [when recessed]. Dock lifts can be used instead of dock levelers, but since they must be moved from truck height to dock height with each load, they are not often used with forklifts or high volume installations. The dock lift size, capacity, and type of mechanism must be specified. Every possible safety device and safety option should be required and specified. Key operated mechanisms are required to control and restrict operation.

   E. Dock Leveler Truck Locks: At truck docks for large tractor trailers and where fork lifts are expected to be used, provide truck locks which catch and hold the truck to the dock. These are used to prevent the unexpected movement of the truck away from the dock [either intentional driving away or accidental rolling away]. These are safety devices which are intended to reduce accidents and injury to forklift drivers whose vision is often obscured by the load on the forklift.

   F. Dock Seals and Shelters: At major loading docks for energy conservation and interior comfort, provide adjustable dock seals to close the gaps between the truck and the building.

   G. Dock Lighting: At major loading docks, wall mounted adjustable arm lights should be used to increase lighting inside truck body and to promote safe working conditions. These must be coordinated with electrical Contract Documents and clearances must be verified.

   H. Signs: "Shut Off Engine" signs are required at loading docks. See Section 10440.

END OF SECTION

SECTION 11170 - WASTE HANDLING EQUIPMENT & RECYCLING

1. **General:** The Designer must have a thorough understanding of the types of wastes to be handled before designing the waste handling system. Biology labs and chemical labs often require special waste handling systems. Laboratories in many departments require waste handling for sharps, chemical waste and broken glass.

   A. Renovation work and changes in space use may change the type of waste generated, and the suitability of the existing waste handling system must be reviewed even if waste handling is not explicitly listed as part of the project scope of work.

2. **Waste Handling Outside Buildings:**

   A. Locate trash compactors and containers away from building ventilation air intakes to prevent odors from entering into buildings and to prevent windblown trash from clogging ventilation louvers and screens.

   B. Use trash compactors with loading access by mechanical lift or ramp; do not expect M.I.T. staff to lift heavy trash containers into compactors.

   C. Provide heaters for hydraulic compactors exposed to freezing temperatures, where necessary.

   D. For rubbish containers, ensure there is adequate clearance and access for waste removal truck.

   E. Provide minimum 6 inch thick air entrained, 4,000 lb reinforced concrete pads with 6" gravel base and 6 x 6 #10 wire under all compactors and dumpsters. See Section 02500 - Paving.

   F. Clearly specify that M.I.T.'s new or existing trash compactors and dumpsters cannot be used for construction debris or temporarily used during construction. The Contractor must provide its own dumpster for construction debris removal.

   G. Visually screen compactors and dumpsters with walls, fences, or other means approved by M.I.T. Grounds Department Manager and M.I.T. Planning Office. Engineer walls and fences to withstand high winds.

   H. Fixed trash compacting equipment will typically be furnished by M.I.T. for installation by the Construction Contractor. The trash container [dumpster box] will be furnished by the trash removal contractor and is usually Not In Contract [N.I.C.].

   I. The Construction Contract Documents must include rough-in and coordination for powered trash compactors, even if the waste handling equipment is Not In Contract.

   J. To facilitate cleaning of trash compacting equipment, locate storm drain catch basins and water supply near trash equipment locations. For waste handling equipment which may receive dangerous or hazardous chemicals or contaminants and not just ordinary trash, an effective method of passively preventing leaking chemicals or contaminates from entering the storm drainage system is required. Use watertight containers to contain leaks. Provide dikes, dams, or valves at catch basins with require intentional opening to permit controlled drainage from the trash area to the storm drainage system.

   K. Because of the likelihood of trash fires, ensure there is proper fire lanes and fire access for fire fighting apparatus. Do not locate trash containers near combustible walls assemblies.

3. **Waste Handling Inside Buildings:**

   A. Provide a trash/rubbish room to comply with programmatic requirements listed in Appendix A and in 527 CMR 34.

   B. Trash/rubbish room must be sprinklered to comply with requirements of Section 15300. Unheated spaces must have dry "Pre-Action" systems and not compressed air systems.

   C. Design rooms, doors and room ventilation to contain the odor from refuse.

4. **Hazardous Waste Handling and Procedures:**

   A. Hazardous Waste Incineration: Incinerators are often located near animal facilities. Incinerator rooms must be sprinklered to comply with requirements of Section 15300. The Designer must consider and propose methods of removing ashes safely with minimum dust. A central incinerator for campus wide use is under consideration.

   B. The Designer should contact EMS and IHO early during design for special hazardous waste procedures and requirements.

5. **Containers:** The Fire Prevention Regulations 527 CMR 34.05 require that containers meet specific criteria to assist in the prevention and extinguishing of fires. Consult the Regulations for the specific requirements before specifying the equipment.

6. **Recycling:** Recycling areas should be located in the vicinity of the rubbish collection points. Considerations for recycling storage are the same as waste handling. Size of recycling storage sites will vary with building size. Final site approval will be made by M.I.T. Grounds Services.

END OF SECTION

SECTION 11400 - FOOD SERVICE EQUIPMENT

1. **Food Service Equipment:** The Designer must work closely with M.I.T.'s Department of Housing and Food Services. Specialist food service equipment consultants may be needed to determine the type and size of equipment needed.

2. **Standards:** Food service equipment must comply with National Sanitation Foundation standards and bear the NSF seal of approval. Electrically powered work must be UL listed. The following NFPA standards must be followed:

   A. NFPA 70: National Electrical Code

   B. NFPA 96: Removal of Smoke and Grease Laden Vapors from Cooking Equipment

   C. NFPA 54: National Fuel Gas Code

3. **Steam:** Do not use M.I.T. Central Plant steam for food service uses since Central Plant steam service may be curtailed during warm weather months.

4. **Lighting:** All lamps in food service areas are required to be plastic coated to prevent the glass from shattering in the event of a break.

END OF SECTION

SECTION 11470 - AUDIO VISUAL EQUIPMENT
(New Section)

1. **Assistive Listening Systems:** When constructing or renovating assembly spaces, the Designer should consider the requirements for Assistive Listening Systems as defined in the ADA and MAAB. Wherever possible, M.I.T. prefers the installation of infrared systems over other alternatives. RF frequency systems may be preferable in certain circumstances because infrared is primarily dependent on line-of-sight to function. In any case, the selection and design of the system to be installed should be determined with the M.I.T. Project Manager and representatives of the M.I.T. Audio-Visual Department.

END OF SECTION

SECTION 11610 - FUME HOODS

1. **Fume Hoods:** Fume hoods are special enclosed mechanical devices to permit working with hazardous or toxic substances in a controlled air flow which directs air away from the user and exhausts the air outside the building.

   A. There are many choices and variables in fume hood selection and specification, and the Designer must have a clear understanding of the types of fume hoods and options required for the project.

   B. In addition to discussing fume hoods with users, the Designer must obtain review and approval from M.I.T. Environmental Medical Service, Industrial Hygiene Office (E.M.S.-I.H.O.), and M.I.T. Safety Office early in the design phase.

   C. Hoods should be submitted to E.M.S.-I.H.O. for testing in their facility. The day-to-day demands on the office may cause the procedure to take 2-3 weeks to complete. Fume hoods should be specified which have already been approved for their particular application. The M.I.T. Project Manager can provide the list of approved hoods.

   D. A fume hood monitor must be provided for all installations. For variable air volume (VAV) applications it may be incorporated into the face velocity control. Otherwise, it shall be purchased with the hood. The list of approved hoods provides more detailed information on this matter.

2. **Fume Hood Locations:** Fume hood performance is affected by room drafts, air movement within the room, and by people circulation. Fume hood users often prefer fume hood locations which EMS believes are less than ideal. Review fume hood locations with EMS early in the design phase.

   A. In particular, fume hoods installed adjacent to a wall with a narrow “access aisle” (for example, a lab bench and shelving which extends to the ceiling installed opposite the hood face) have been troublesome. The air must enter the aisle and make an abrupt 90 degree turn to enter the hood. This creates excessive turbulence at the corner of the hood nearest the alcove’s back wall. If the design program leads to a layout of this nature, please review it with E.M.S. before proceeding. The cross sectional “free area” of the space leading into the hood should be at least five times the hood face area.

3. **Energy Issues:** Since fume hood systems can exhaust large volumes of conditioned air, energy is a major criteria which must be evaluated before selecting and specifying the system. Laboratories using chemical fume hoods should be ventilated at a minimum rate of six air changes per hour. Some recent research at Los Alamos Laboratories indicates that eight air changes per hour results in optimum contaminant control.

   A. Due to the energy intensive nature of fume hood operation, constant volume hoods are only to be used where other systems (i.e. VAV or two speed) are not technically or economically feasible, or where the minimum room ventilation rate dictates a constant volume system. In each application, a careful study must be performed to evaluate control options. This will identify what type of system is most appropriate. M.I.T. currently uses Phoenix and TSI systems for continuous VAV control. The minimum hood ventilation quantity to maintain effective containment is 45 CFM per nominal linear foot of hood. This will dictate the minimum air quantity which can be achieved with VAV control in cases not otherwise limited.

   B. Auxiliary exhaust requirements (i.e. sucker hoses) shall be programatically evaluated at the beginning of a renovation project. If the need exists, a separate Phoenix independent constant volume exhaust valve or a separate auxiliary exhaust system shall be employed. Although separate dedicated fan systems are generally preferred by EMS, sucker hoses with a minimum requirement of less than 100 CFM can generally be accommodated along with a VAV system.

4. **Exhaust Ducts:**

A. Fume hood exhaust duct materials must be reviewed with and approved by M.I.T. Safety Office and EMS Industrial Hygiene Office.

B. All air cleaning devices proposed for use must be reviewed with and approved by M.I.T. EMS Industrial Hygiene Office.

5. **Specify the Fume Hood Type:** The basic types of fume hoods include:

A. Standard Fume Hoods: Standard fume hoods (without bypass) are not acceptable at M.I.T. because as the sash is lowered, the face velocity increases [because the same air volume must pass through a smaller opening] resulting in noisy, disruptive, and objectionable conditions.

B. By-Pass Fume Hoods (constant volume and variable volume): Uses room air to exhaust contaminants. When used in the constant exhaust air volume mode, variation in face velocity is limited by additional air which is allowed into the hood working area through the by-pass opening. In VAV applications, the bypass may be partially or fully blocked to allow the controls to provide the energy saving "constant face velocity".

C. Auxiliary Air Fume Hoods (constant volume): Uses room air with supplemental air ducted to the top face of the hood external to the sash to exhaust contaminants. This type of hood and system significantly reduces the quantity of conditioned room air lost through the hood and can offer significant energy savings if designed correctly and operated properly. It is highly recommended for energy savings particularly in areas of high fume hood density where bypass hoods and a cool air supply tend to over cool spaces or require reheat of room air.

D. Perchloric Acid Fume Hoods: These hoods have special interior finishes and features including a wash down wand mounted behind the upper baffle. The duct runs are equipped with wash down nozzles. These hoods are reserved exclusively for perchloric acid work, and are always on a dedicated fan system. The duct runs for these systems should be as straight as possible, with the horizontal runs minimized. All horizontal runs shall be pitched back to the hood for drainage. Horizontal runs pitched to an elbow "up" provide areas for the wash down water to accumulate and dry out, thus forming the explosive crystal perchlorate.

E. Isotope Fume Hoods: These hoods have special interior finishes and features to accommodate the special needs of radiochemical work. They also feature welded seamless construction and coved corners to facilitate cleaning and decontamination.

F. Walk-In Fume Hoods: Special hoods designed for large or complex apparatus and for cart mounted equipment or instruments. Most fume hoods are bench mounted.

G. Glove Box Fume Hoods: Special hoods designed to completely isolate the user from contact with the interior through the use of a complete enclosure and hood attached working gloves.

H. Other Fume Hoods: There are other contaminant control hoods for other specific applications. These specialty hoods require extensive I.H.O. review and may require individual containment testing.

6. **Specify the Face Velocity:** Generally, 100 fpm is adequate for contamination control if the hood is designed properly and if the hood is located to eliminate cross-drafts from ventilation system and from traffic circulation. In superior locations 80 fpm may be approved by EMS.

7. **Specify the Interior Liner:** Several interior liners are available and each has its appropriate use.

   A. Calcium Silicate Liner: Non combustible, good chemical resistance, low cost, but absorption can be a problem. Epoxy paint can improve the absorption and cleaning characteristics.

   B. Fiberglass Reinforced Polyester Liner: Non-porous, excellent chemical resistance, easy to clean.

   C. Molded Epoxy Resin Liner: Non-porous, highest chemical resistance, easy to clean.

   D. PVC Polyvinyl Chloride Liner: Non-porous, excellent acid resistance, easy to clean.

   E. Stainless Steel Liner: Non-porous, easy to clean, often used for isotope work. Not for use with halogenated compounds.

8. **Specify the Working Surface:** Several working surfaces [horizontal work counter within the hood] are available and each has its appropriate use. Working surfaces should have 1/4" deep recesses at least 2" from entire perimeter to contain spills.

   A. Molded Epoxy Resin: Non-porous, highest chemical resistance, easy to clean, will not blister or crack, non-glare black finish, available with integrally molded splashes and attached epoxy resin sinks which appear to be nearly seamless.

   B. Resin Impregnated Stone: Porous inert seamless sandstone with resin finish, non-absorbent, non-staining, chemical resistant, can support heavy loads,

   C. Fiberboard with Resin Finish: Less expensive, but has limited chemical resistance and water resistance.

   D. Stainless Steel: Non-porous, easy to clean, good chemical resistance, but not for use with halogenated compounds. Often used for food, sterile, and radiological isotope work.

   E. Plastic Laminate: Fair chemical resistance. Only useful for light duty applications. Limited applications at M.I.T.

   F. Wood with Resin Coating: Butcher block wood tops with chemical resistant resin finishes are available. These are not often used.

9. **Specify the Services and Fittings:** Fume hoods must be equipped with the correct services and the proper fitting and outlet for the services. The location of the service needs to be indicated. The type of fitting and orifice must be specified [serrated hose fittings, aerator gooseneck, remote valves outside fume hood working area, and other important decisions].Typical services include:

   A. Cold Water
   B. Hot Water
   C. Distilled Water
   D. Steam
   E. Natural Gas
   F. Compressed Air
   G. Vacuum
   H. Special Gases [Oxygen, Nitrogen, Hydrogen, and others]
   I. Electrical Power [both standard voltage and special voltages]
   J. Sink assemblies [size, shape, and type of sink; traps and tailpieces; strainers; vacuum breakers]

10. **Specify Clarification of Trade Jurisdiction for Fume Hood Services:** This is a very common problem that should be avoided. Fume hoods can be shipped with most of the services completed at the factory for final connection at the jobsite or shipped with the services in parts for assembly at the jobsite. Factory installation of services is normally the best option._You must clearly define the limits of factory and site work to avoid Change Orders and project delays.

    A. Space Change Projects: For space change projects, schedules often require the use of a readily available "quick ship" fume hoods. The quick ship hood services will be shipped loose for field assembly. The specifications must make the requirement for field assembly clear so Change Orders for doing the field assembly work are avoided.

    B. Larger Projects: Since factory labor may be cheaper and more experience with fume hood work than field labor, and since project schedules may be easier to meet with less on-site work, specify that all services and systems throughout the fume hood be completed factory assembled with only rough-in and final connection done at the site.

11. **Specify the Base Cabinet:** Fume hoods are most often bench mounted and the type of base condition must be indicated. The base cabinet materials, construction, and hardware must be specified or specified as a manufacturer's standard base assembly.

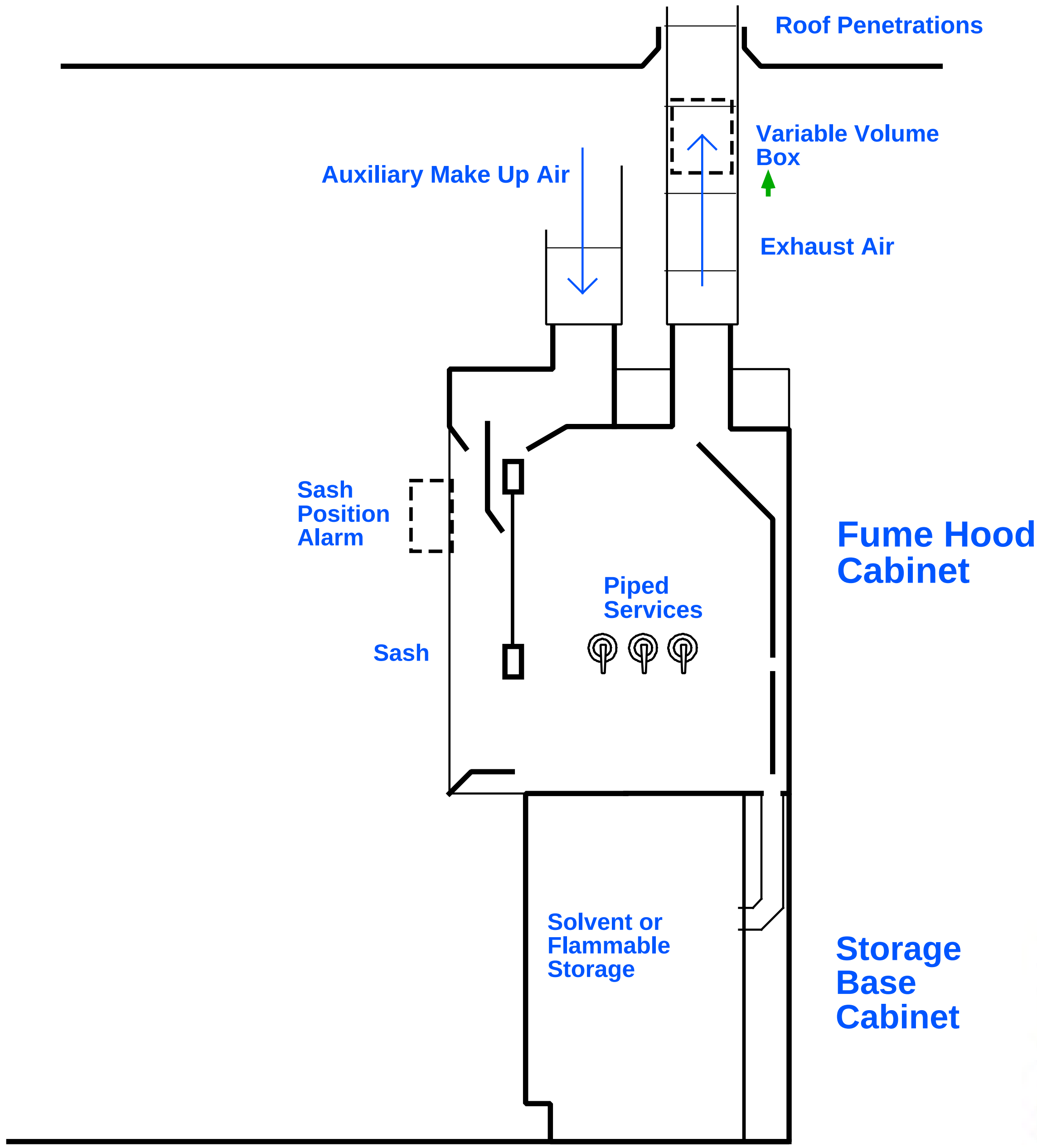
    A. Acid storage cabinets have corrosion resistant liners and are vented into the hood by one or two 1 1/2" (nominal) diameter acid resistant pipes which lead to the interior of the hood, behind the baffle.

    B. Solvent storage cabinets must meet NFPA 30 and be Factory Mutual approved and labeled. These cabinets are used for storage of flammable and combustible liquids, and have ±2" deep leak proof pans at the base of the cabinet to contain spills. Solvent cabinets must be labeled "Flammable - Keep Fire Away". Flammable storage cabinets are not to be vented.

12. **Consider Maintenance:** For fume hoods with operable sash, specify that sash must be easily removable for repair and service, that sash balances must be easily accessible and simple to repair and maintain. If the counterbalance is offset at the back of the hood or located on one side, it should favor the side which is easiest to access. Light fixtures must be accessible from outside the hood.

13. **Fixed Fan Belt Sheaves:** Specify that fixed sheaves be installed by the contractor after air balance is accepted by M.I.T. The adjustable sheave shall be retained for future balancing use by attaching it in a suitable location to the fan frame.

END OF SECTION



MIT Facilities Fumehood Design Requirements

click on topic for more information

11 EQUIPMENT - Fume Hoods

SECTION 11615 - PREFABRICATED ENVIRONMENTAL ROOMS

1. **General:** Environmental rooms are often used in laboratory work and are simply special pre manufactured, panelized, insulated rooms with special interior temperatures and conditions. The basic types of environmental rooms are:

   A. Warm Rooms.

   B. Cold Rooms.

   C. Freezer Rooms.

   Note: This section provides guidelines for thermally controlled environmental rooms only. Clean rooms are not included.

2. **Room Temperature:** You must specify the required room temperature range and the temperature tolerance permitted. For some applications, very tight temperature tolerance [sometimes ±0.5°C] is required. The temperature uniformity and gradient within the environmental room must be specified. The type of temperature sensor must be specified.

   A. Solid shelving and other furnishings and fixtures which disrupt air flow used in environmental controlled temperature rooms will likely cause temperature gradients and prevent lack of uniform temperature within the room.

3. **Room Humidity:** You must specify the required room humidity and whether humidifiers or dehumidifiers are required.

4. **Controls:** You must specify the control systems and the type of recorders to show the fluctuation of conditions within the room [the recorders are needed since experiments are often conducted within the environmental rooms]. Alarms are typically provided to warn of environmental control failure. The alarm must be located to be heard when the area is not occupied; remote alarms may be needed.

5. **Environmental Room Locations:** All environmental rooms in the building of one type [example: freezers] are often stacked vertically in flat concrete slab structures so that no insulated floor or ceiling panels are needed, except at the top and bottom floors.

6. **Blocking:** Environmental rooms are constructed with insulated sandwich panel walls, ceilings, and sometimes floors. The core of the sandwich is usually foam insulation and the skins are thin sheet metal. Typical standard environmental room panels do not support applied loads or readily accept screws or fasteners supporting loads. If wall hung or attached shelves, cabinets, or equipment is to be installed in the environmental room, special blocking must be clearly specified and indicated.

7. **Mechanical Systems and Back-Up:** For cold and freezer rooms, the type and location of condensing units must be indicated. Both water and air cooled units are available. Back-up systems are sometimes needed to ensure that power failures and other failures do not disrupt the scientific work.

   A. Water Systems: Use chilled water and do not use domestic water for cooling. Domestic water may be used for emergency back-ups systems.

   B. Air Systems: Do not locate air cooled equipment in occupied spaces, unless you are certain that the space can accept the additional heat. Remote condensing units are usually required and should be used.

   C. Consider energy and maintenance costs when specifying environmental rooms.

8. **Ventilation:** Environmental rooms with chemical uses such as thin layer chromatography, electrophoresis (which may on occasion require special fire protection and electrical protection), and other uses may need special ventilation and exhaust. Verify the need for special ventilation and exhaust on a user by user basis through the M.I.T. Project Manager. Consider energy recovery systems such as heat exchangers to reduce energy loss due to ventilation and exhaust.

    A. Restricted Chemical Use: If using flammable liquids, then the Designer must consider special electrical wiring requirements necessary to meet code.

9. **Personnel Alarms and Safety:** Since the environment within the rooms can be dangerous after long exposure, doors to environmental rooms must be fail safe and must have easily operable interior releases. Hardware must be selected and designed such that persons may not be accidentally locked in. Manually operated alarm buttons should also be provided within the rooms.

10. **Architectural Finishes and Lighting:** Finishes such as floors and ceilings and interior room lighting are typically provided as part of the environmental room assembly and must be specified.

    A. Architectural Trim Outside Rooms: Sometimes environmental rooms do not extend from the floor to the structure above and have their own insulated ceilings. Often machinery and equipment is located on top of the environmental room. If desired, you must specify closure panels and trim to close the space between the top of the environmental room and the building structure or ceiling above. Ensure that equipment located on top of environmental rooms is properly ventilated, especially when architectural trim and closure panels are provided around the equipment.

11. **Ramps:** If insulated floor panels are used and the structural support under the room is not depressed to accommodate the floor panel thickness, ramps outside the environmental room will be need. If the ramps are not planned properly, the ramp can interfere with circulation outside the environmental room. All ramps should have a minimum slope of 1:12 wherever possible.

12. **Vibration:** Sometimes scientific work within or adjacent to a environmental control room is highly vibration sensitive. Motors, machines, and equipment related to the environmental control room must be positioned or isolated to prevent disruption of the scientific work.

13. **Insulation:** Environmental rooms must not use foam insulation which requires CFC blowing gases. Only environmentally safe insulation is permitted for work at M.I.T.

14. **Electrical:** Power and lighting wiring shall be in accordance with the requirements of Section 16. Fluorescent light fixtures shall be provided with electronic ballasts and T8, 3500K lamps. Receptacles and light switches shall be 120V-20A (minimum). Separate neutral and ground conductors for each circuit shall be provided as called for in Section 16. GFCI's shall be provided as appropriate. In rooms using flammable liquids with low flash point vapors, electrical wiring should be installed in accordance with N.F.P.A. 30 and N.F.P.A. 70.

15. **Fire Protection:** Sprinkler coverage shall be provided when fire protection water is available. Freezer boxes should have dry pendant heads installed. Sprinkler head activation temperatures should be appropriate for the operating temperature of the box.

END OF SECTION

DIVISION 12 - Furnishings

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SECTION 12345 - LABORATORY CASEWORK

1. **General:** Laboratory casework can be either premanufactured casework or custom manufactured casework.

2. **Materials:** Laboratory casework is typically one of the following:

   A. Wood: Particleboard or fiberboard which can have problems when wet and must not be used. Specify only solid wood materials. Veneer species, cut, and matching must be specified. Premanufactured wood casework cannot have veneers matched between units as is possible with custom casework. Wood casework is recommended for use at M.I.T.

   B. Plastic Laminate: M.I.T. has had poor results with plastic laminate laboratory casework and discourages its use. Particleboard or fiberboard which can have problems when wet and must not be used. Specify only solid wood and water-resistant plywood materials. Thickness, grade, and quality of laminate must be specified. Extent of laminate covered surfaces must be specified [drawer sides, drawer bottoms, shelf edges, and so on]. Avoid self-edging, where possible.

   C. Steel: Formed and welded steel cabinets can rust and show dents and scratches. M.I.T. uses metal casework in some instances.

3. **Casework Hardware:** You must specify the casework hardware in detail to control quality. Inferior quality hinges are a common problem at M.I.T.; specify institutional quality 5 knuckle butt hinges wherever possible. Specify high quality ball-bearing drawer slides with load capacity appropriate for the intended use. Drawer and door pulls should be barrier-free but should not protrude in a manner which suggests the pull could be used as a step [a common problem for lower drawer pulls].

   A. Casework Hardware Availability: Hardware used on casework must be readily and commonly available. Use hardware which has been available for a long time and which is expected to be available long into the future.

4. **Countertops [Working Surface]:** Several working surfaces are available and each has its appropriate use. Do not use any material containing asbestos.

   A. Molded Epoxy Resin: Non-porous, highest chemical resistance, easy to clean, will not blister or crack, non-glare black finish, available with integrally molded splashes and attached epoxy resin sinks which appear to be nearly seamless. Often used at M.I.T.

   B. Resin Impregnated Stone: Porous inert seamless sandstone with resin finish, non-absorbent, non-staining, chemical resistant, can support heavy loads. Not often used at M.I.T.

   C. Stainless Steel: Non-porous, easy to clean, good chemical resistance, but not for use with halogenated compounds. Often used for food, sterile, and radiological isotope work. Often used at M.I.T.

   D. Plastic Laminate: Fair chemical resistance. Only useful for light duty applications. May be used at M.I.T. only for desks and writing surfaces within labs, but not for lab working surfaces.

   E. Wood with Resin Coating: Butcher block wood tops with chemical resistant resin finishes are available. These are not often used at M.I.T. May be used at M.I.T. only for desks and writing surfaces within labs, but not for lab working surfaces.

5. **Countertop Seams:** You must specify and control countertop seam location, especially for stone and resin countertops. We have had problems with having far too numerous seams and countertops pieces, enough to make using the countertop for lab work difficult.

   A. You must specify and control the “flushness” of countertop seams, especially for stone and resin countertops. If there are lips at the seams, the user cannot slide glassware and apparatus across the counter without the item possibly falling over.

   B. Grout: Use only epoxy grout on counter top seams.

6. **Accessibility:** Refer to Division 1 - Uncommon Ordinances and Requirements for specific information and requirements for accessible laboratory work stations.

END OF SECTION

SECTION 12500 - WINDOW TREATMENT

1. **Standard:** M.I.T.'s standard window treatment is horizontal blinds [Levelor 2" 962 Silver]. The Designer should select the appropriate model for the application, budget and warranty.

   A. Special window treatment such as drapery and room darkening shades may be needed for special applications and spaces. Review proposed special window treatment with M.I.T. Manager of Design and Construction before use.

      1) Due to previous experience at M.I.T., the use of electrically operated black-out shades is discouraged. M.I.T. prefers manually operated black-out shades.

2. **Maintenance Issues:** Use only high quality window treatment for which replacement parts are readily available.

3. **Window Film:** Guidelines for window film are covered in Section 08800.

END OF SECTION

SECTION 12690 - ENTRANCE MATS

1. **Locations:** Recessed entrance mats should be provided in vestibules. M.I.T. Building Services will place additional surface mounted entrance mats in main lobbies and near building entrances during wet months.

2. **Mats Sizes:** Use mats of size and type so they can be rolled and moved by one maintenance person.

   A. Mats that are 1/2" or less in thickness must be anchored around all edges to avoid tripping. Mats that are greater than 1/2" thick must be recessed into the floor.

3. **Mat Types:** Use mats which can be easily washed and cleaned. Use reasonably long-wearing mats. Avoid use of cocoa fiber mats since they must be replaced frequently. Construction Specialties "Pedigrid" and "Pedimat" with carpet inserts have been used with success at M.I.T. Pedigrid is constructed of a metal frame that must be recessed into the floor. The recess must be designed to either contain water (from melting snow, etc.) or be sloped to a drain.

   A. The Designer should detail metal-framed mats so as to reduce noise and clatter that occurs from walking on the mat.

END OF SECTION

SECTION 12750 - FURNITURE

1. **Riser Mounted Seating:** In classrooms, auditoriums and other locations where fixed seating is proposed, M.I.T. prefers riser mounted seating over floor mounted seating for ease of cleaning. However, the Designer must take care to review the stresses involved and the type of riser before a final determination can be made.

2. **Workstations:** M.I.T. has identified one of the leading causes of Repetitive Stress Injuries (RSI) to the selection and installation of incorrectly or inadequately designed workstations. When considering a workstation, particularly one to be used for computing, the Designer should confirm that the surface is adjustable or provided with an adjustable keyboard tray.

END OF SECTION

SECTION 12800 - INTERIOR PLANTING

1. **Interior Planting:** This section covers interior planting in main lobby areas and public areas. This section is not intended to address interior planting belonging to building occupants.

2. **Interior Planting Maintenance:** Interior planting will require regular maintenance and plant replacement. When considering the use of interior planting, please remember that the maintenance budget may not be increased to care for the plants. Use interior planting only where approved by Manager of Grounds and Planning Department.

3. **Interior Planters:** Line interior planters to prevent water leaks. Create waterproof "bathtubs" even if potted plants are expected to be used in the planter.

4. **Interior Planting Details:** Large interior plants and trees probably need large, soil filled planters. Other planting should be potted plants placed into the building planters. The pots should be recessed into lightweight, non-combustible, non-absorbing filler. Non-combustible mulch should be spread to conceal the filler and the pots. The plants will look like they are planted into soil. The maintenance staff will be able to quickly remove an entire pot and replace it with another without having to truly dig and plant.

5. **Lighting:** For live plants, the quantity and quality of lighting must be carefully determined.

6. **Water:** For interior planting with large numbers of live plants, a nearby water source is essential. Do not expect Building Services to haul water.

7. **Pesticides:** All pesticides must be reviewed with and approved by M.I.T. Environmental Medical Service before use.

END OF SECTION

DIVISION 13 - Special Construction

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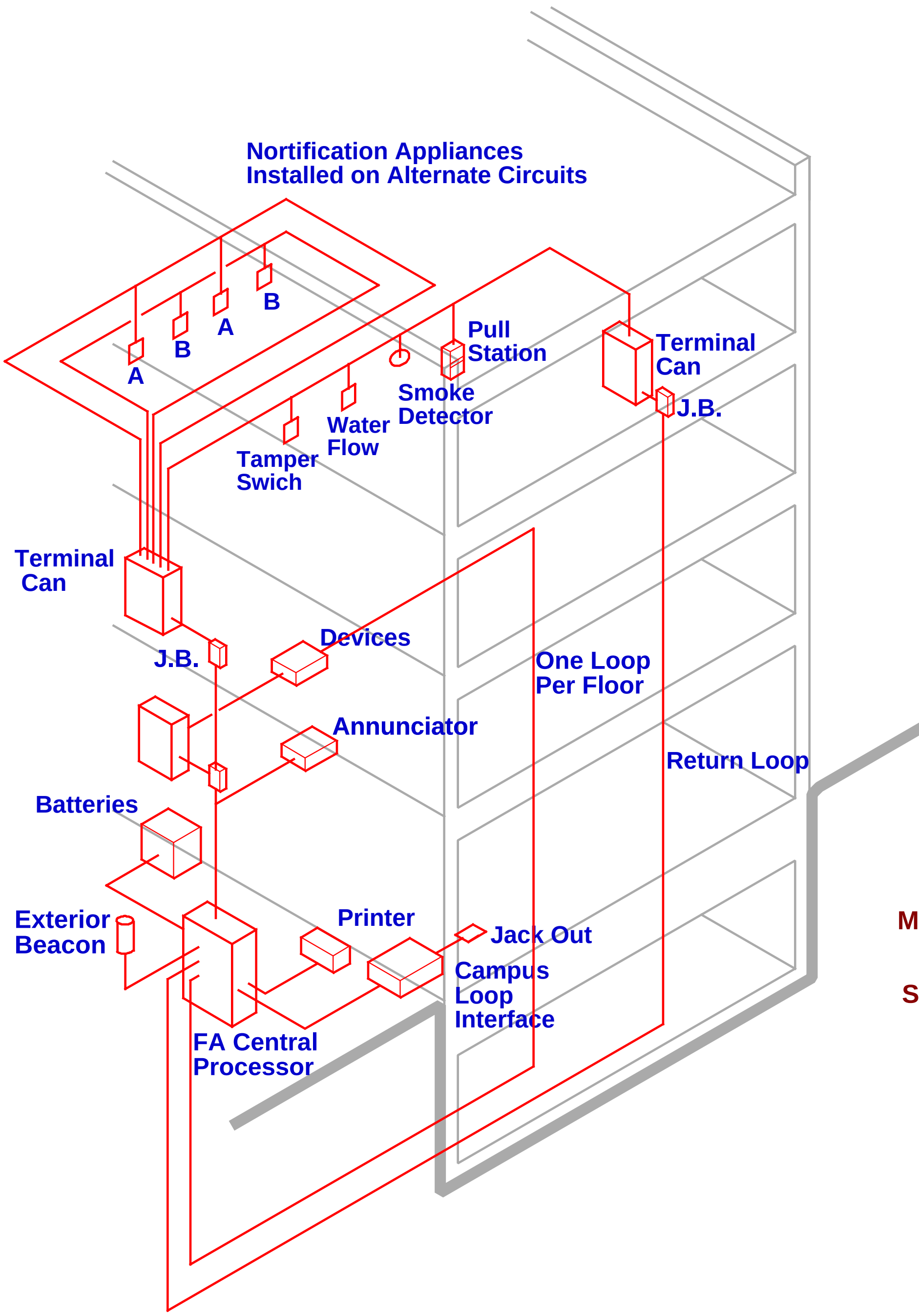
13 FIRE PROTECTION



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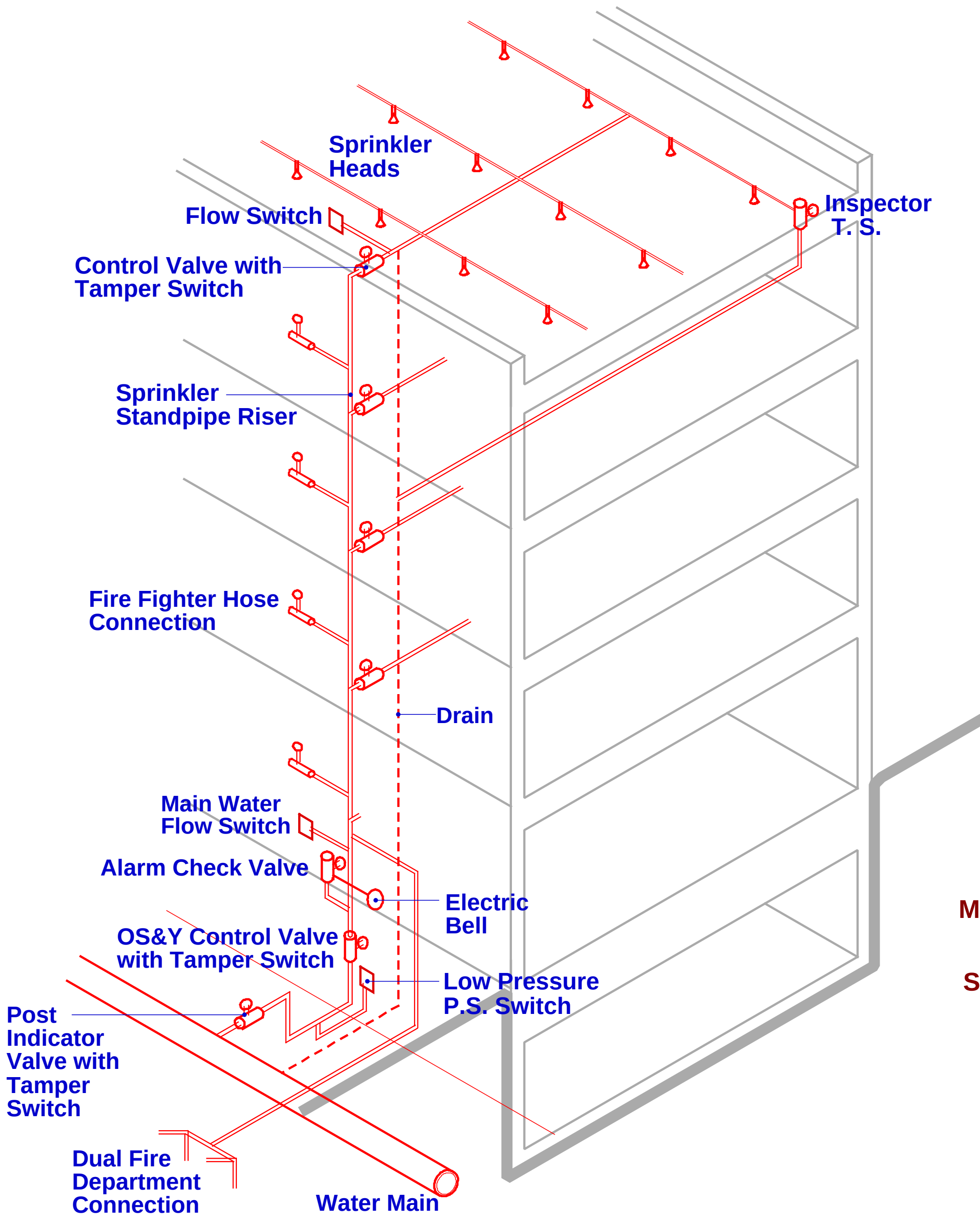
(click here for Sprinkler System)

(click here for Required Engineering Documents)

MIT Department of FACILITIES
BUILDING SYSTEMS
DESIGN HANDBOOK

ver. 1.1



MISSION STATEMENT A
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FIRE PROTECTION: SPRINKLER SYSTEM

(click here for Fire Alarm System)
(click here for Required Engineering Documents)

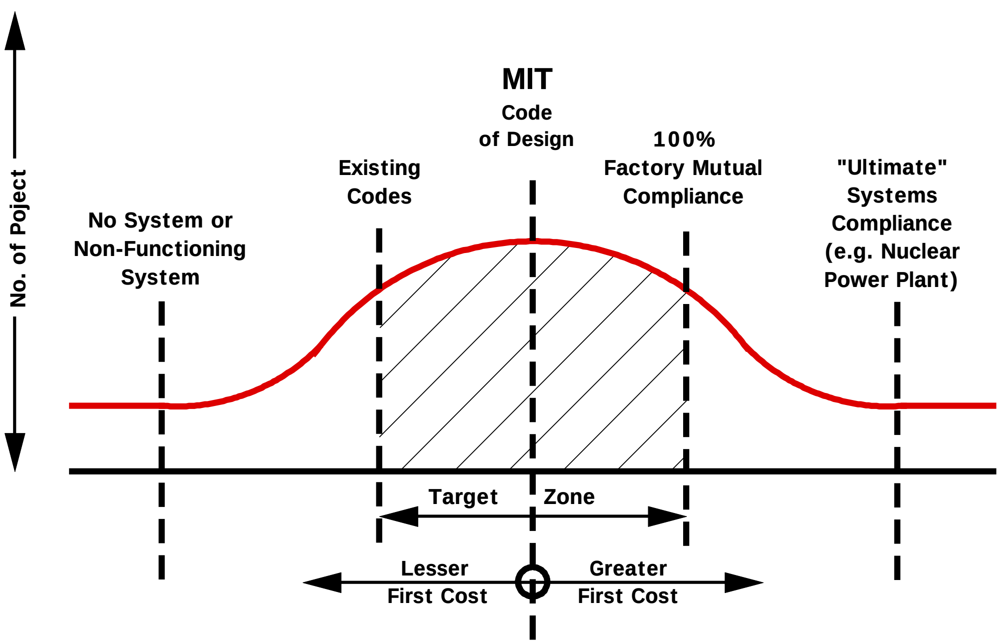
Miission Statement

MIT's fire protection goal is to provide 100% coverage (including electric rooms) in all of its facilities. In existing buildings, MIT seeks to bring all renovated areas into conformance with Institute standards through a strategy of determining the prudent course between achieving higher levels of fire protection and budgetary responsibility.

Levels of Fire Protection in Existing Facilities

+5	Facility designed for and meeting "Ultimate Systems" Protection
+4	Facility designed for and meeting 100% Factory Mutual Standards
+3	Facility designed for and meeting MIT Code of Design
+2	Facility designed for and meeting Existing Fire Protection Codes
+1	Facility designed for and meeting Past Fire Protection Codes
-1	Facility with non-functioning fire protection systems
-2	Facility with no fire protection systems

The following diagram depict s the distribution profile of protection of the existing facilities at MIT. The hatched area represents the target levels of conformance in facility renovation projects.



Profile of Existing Facility Fire Protection
Conformance Target Levels are shown hatched.

Top Ten Fire Protection Issues

(not prioritized)

1. *Do* provide adequate allowance of time for commissioning and testing.
2. *Do* maintain fire protection equivalency during renovations.
3. *Do* maintain fire protection coverage during demolition.
4. *Do* coordinate the fire alarm design with the fire sprinkler design.
5. *Don't* meet with the fire department without MIT approval.

Top Ten Sprinkler Issues

(not prioritized)

1. *Do* state design densities at the beginning of each project; use MIT requirements (see MIT fire protection coverage chart).
2. *Do* provide an inspectors' test station, piped directly to the drain, at the hydraulically most remote point of every sprinkler system.
3. *Do* provide fire protection in all concealed spaces that contain combustible material or the potential for combustible materials (such as wiring)
4. *Don't* install looped sprinkler systems.

Top Ten Fire Alarm Issues

(not prioritized)

1 *Do* provide the building with full coverage of audible and visual alarm notification appliances.

2 *Do* coordinate testing of fire alarm, emergency power, HVAC, FCS and elevators.

3 *Don't* install wire other than stranded wire.

4 *Don't* install systems requiring special staging or ladders longer than standard stepladders for routine maintenance or testing. Accessibility is a primary concern for locating fire detection devices.

Special MIT Design Requirements

Fire Alarms

All fire alarm systems shall conform to the latest edition of NFPA 72 adopted by Massachusetts and each control panel shall have a RS485 port reserved for future connection to the campus-wide monitoring system. see ISOMETRIC DRAWING

1. Initiation Devices
    a. Pull stations shall be double action and mounted at 48 inches AFF.
    b. Smoke detection devices shall have the folloiwng features:
        1) Spot Detectors shall be photoelectronic.
        2) Duct detectors shall be mounted such that they are accessible for service and have a remote test and indicating station. Duct detectors shall be programmed to provide a supervisory signal.
        3) Beam detectors shall only be used where they are accessible for service with a normal step ladder.
        4) Aspirating detection shall be an engineered system and detailed drawings provided.
        5) Any smoke detectors mounted in normally locked rooms shall have a remote indicating light.
    c. Heat detectors shall be of the fixed temperature type only. Any heat detectors mounted in normally locked rooms shall have a remote indicating light.
    d. Water flow detectors shall be vane type with retard.
    e. Supervisory signals shall include:
        1) valve tamper,
        2) low air, and
        3) low water pressure to the building.
    f. Notification appliance circuits shall be loaded no more than 2/3 of the manufacturers stated capacity to allow for future connections. There shall be a minimum of two notification appliance circuits per floor.
        1) Horn strobes or speaker strobes shall be mounted at 80+/- 1" AFF.
        2) A red 24 VDC rotating beacon shall be provided and mounted outside of the building at the location of fire department entry.
        3) The notification appliances located in the housemaster's apartment shall be on a separate dedicated circuit.

2. System Power
    a. Power for the entire fire alarm system shall be provided by a Dualite Spectron [R] LSN power system containing backup batteries with 24 hour capacity.
    b. There shall be a minimum of a 20 percent safety factor.
    c. The power supply unit shall provide signals for charger failure, overcharge, and common trouble.
    d. Door holders shall be 24 VDC powered from the fire alarm system. Provisions shall be made to provide a 10 second delay before release of the doors.
    e. Controlled access doors on all levels shall be released upon activation of the fire alarm system.
    f. Elevator recall interface shall be provided for primary floor, secondary floor and elevator machine room.
    g. End of line resistors, where used, shall be in the floor terminal cabinets at the riser.
3. Residential Fire Alarm
    a. Residential fire alarm systems shall consist of a bedroom smoke alarm system.
    b. The system shall be connected to a separate monitoring panel mounted in the house managers apartment which annunciates each room or suite.
    c. Detectors in suites shall be interconnected. The system shall be AAB/ADA compliant.

Suppression Systems

Suppression systems shall conform to the latest editions of NFPA 13 and NFPA 14 adopted by Massachusetts.

1. Automatic Sprinkler Systems see ISOMETRIC DRAWING
   a. Supply for the system shall be provided from either a campus loop or city water as shown on the water supply diagrams for each building.
   b. Pipe penetration through the foundation into the building shall use a Link Seal.
   c. Hydraulic calculations, taken at the top of a riser, shall include a 100 gpm inside hose stream allowance, a 150 gpm outside hose stream allowance and a 10 psi minimum cushion.
   d. Earthquake bracing shall be provided, per NFPA 13.
   e. Densities and temperature ratings shall be as follows:

   see CHART: SPRINKLER SYSTEM DESIGN CRITERIA
2. Wet Pipe Systems
   a. Looped wet pipe systems shall not be installed. Combined automatic sprinkler and standpipe risers should not be interconnected by sprinkler system piping.
   b. The NFPA 13 exception for the elimination of sprinklers in electric rooms shall not be used.
   c. Electric rooms shall have a separate shut off valve and contain upright caged heads.

   see DIAGRAM
3. Dry Pipe Systems
   a. Dry systems shall be designed without exhausters or accelerators. No antifreeze systems shall be used.
   b. All dry systems shall use hot-dipped galvanized pipe and fittings.
   c. 2" and smaller pipe shall be cut and threaded. 2 1/2" and larger pipe shall be roll groved with flush sealed gaskets.
   d. For small areas, i.e. refridgerators, loading docks, etc. use dry pendent heads.
   f. For supervisory air, riser mounted compressors are allowed for small systems (1,500 sq. ft. or less). For larger systems, a reservoir & regulated air compressor is required.
4. Pre-action systems
   a. Pre-action systems shall be reserved for special applications where there are irreplaceable equipment or articles or where conventional systems pose a life safety hazard and shall be single interlocked.
   b. Double interlocked systems are not allowed.
5. Deluge systems

   Deluge systems are for special application only. If used, the design must provide testing capability.

   see DIAGRAM
6. Special systems
   a. $CO_{2,}$ FM-200, and Inergen systems require safety office approval.
   b. Laboratory Hoods shall conform to FM 4910 plastic or be stainless steel. There are no special MIT requirements for fire protection.

Fire Pumps

1. See the diagrams as to where the building is located on the MIT campus to confirm that a fire pump is required.
2. Fire Pumps shall conform to the latest edition of NFPA 20 adopted by Massachusetts.
   a. Electric pumps are preferred; diesel pumps are allowed.
   b. Electric pump motors shall have a synchronous speed of no greater than 1800 rpm.
3. The fire pump system shall be monitored by the fire alarm system system per NFPA 20.

   see DIAGRAMS:

   ELECTRICAL TRANSFER SWITCH

   ELECTRIC FIRE PUMP CONTROLLER REQUIERED SIGNALS DIA.

Fire Command Center

1. A fire command center shall conform to the latest edition of NFPA 72 adopted by the Massachusetts State Building Code and contain the following items:
   a. fire alarm panel and printer,
   b. diesel generator status panel,
   c. telephone with outside line
   d. elevator annunciator,
   e. operating and indicating controls for the HVAC,
   f. stairwell door unlocking,
   g. fire fighter telephone,
   h. building drawings,
   i. lighting on normal & emergency power, and
   j. smoke detector.

Fire Water Main System

1. The campus fire water system is separated into three on-campus loops:
   a. west loop,
   b. central loop, and
   c. east loop (future).
2. Portions of the campus are still fed from city water. See the diagrams to determine the water source for each building.

see DRAWING
see FIRE LOOP PHILOSOPHY STATEMENT

Standpipe

1, Standpipes shall conform to the latest edition of NFPA14 adopted by Massachusetts.
2. The hose stations shall have a 2 1/2" valve with a 1 1/2" reducer and cap without hoses.

The fire department connection shall have standard 2 1/2" fire department couplings. There shall be two siamese connections.

Central Station (UL 827) NFPA 72

1. The MIT main campus monitoring facility is a UL-listed central station.
2. The central station needs to receive the following separate signals:
   a. g arm (pull station, heat, smoke)
   b. water flow
   c. emergency 1
   d, emergency 2
   e. trouble
   f. new trouble
   g. valve closed
   h. emergency generator status
   i. building life safety generator
   j. fire main pump generator
   k. special system alarms
   l. fire pump

3. New buildings shall connect to the nearest central station connection including underground duct banks, manholes, fiber optic cable, copper cable, and radio box. Refer to map (future development)

see DRAWING F4

Infrastructure

1. Cable
    a. Fire Alarm cable shall be 16 gage, stranded minimum and meet the design criteria of the fire alarm system
    b. The cable shall terminate under saddle plates or be terminated with an insulated fork compression terminal
    c. No splices, t-taps or inline terminal block connections are allowed. All wiring shall be point to point from device to device
    d. MIT will supply the fire loop cable to the contractor and charge a fee - allow $2.00/foot.
2. Wiring
    a. All wiring shall be stranded and terminated with fork stacons on devices or screw terminals when located in a panel.
    b. Non-insulated Ferrule type connectors shall be used when wire terminates under a pressure type terminal strip in a fire alarm control panel.
    c. In building systems, raceway shall be 3/4" minimum, EMT conduit with fittings painted red.
    d. No permanent MC cable is allowed. MC cable may be used during construction on a temporary basis.
    e. Wire mold 700 shall be used in exposed finished areas
    f. Terminal cans shall be 14 GA steel painted red and marked Fire Alarm Terminal Cabinet and include Marathon number 312 SP terminal strips.
    g. Conduit fill to be per the Massachusetts Electric Code.
3. Water piping
    a. Piping shall be cement lined, AWWA for fire main use
    b. No fire protection piping shall run under slabs for more than ten feet.
    c. Piping penetration into building shall be by link seal fittings
    d. No plastic piping shall be used in buildings.

4. Wiring legend

Wiring Color Code Schedule to be used at MIT is:

DEVICE	COLORS	COMMENTS
Speakers	Red & black twisted shielded	FPL #14 gauge with a drain (drain to be one gauge smaller, #16) 105E/300V
Flashing lights	Yellow (+) & brown	Return wires to panels from last device to be color coded - yellow with a white stripe and brown with a white stripe.

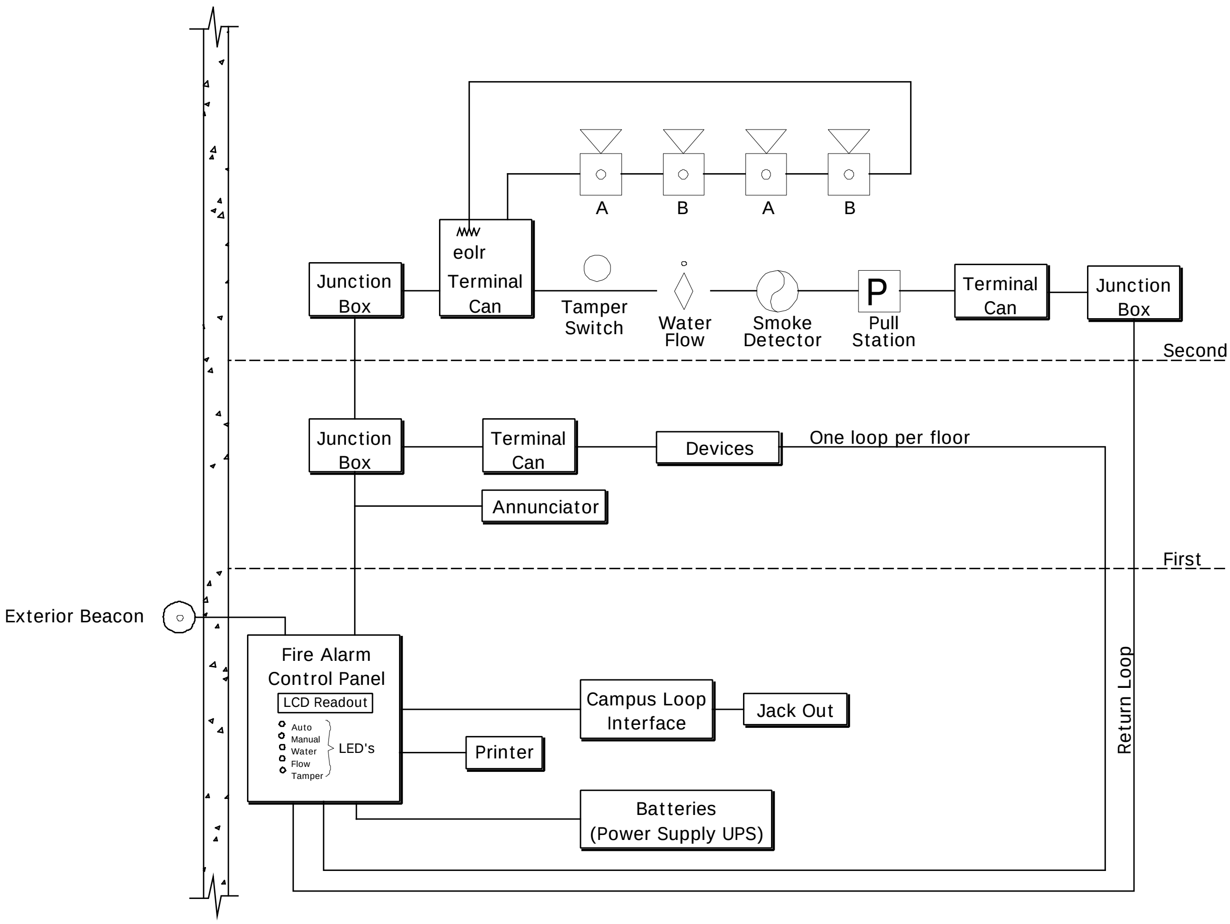
Strobe lights (ADA Xeon or b uilding demarcation strobes	Yellow (+) & brown	Return wires to panel from last device to be color coded - yellow with awhite stripe and brown with a white stripe.
Manual stations	Purple (+) & orange	Return wires to panel from last device to be color coded - purple with a white stripe and orange with a white stripe.
Smoke and heat detector	Purple (+) & orange	Return wires to panel from last device to be color coded - purple with a white stripe and orange with a white stripe.
Duct detector	Purple (+) & orange	Return wires to panel from last device to be color coded - purple with a white stripe and orange with a white stripe.
Waterflow switch	Purple (+) & orange	Return wires to panel from last device to be color coded - purple with a white stripe and orange with a white stripe.
Waterflow supervisory (OS&Y or low air pressure	Pink (+) & tan	Return wires to panel from last device to be color coded - pink with a white stripe and tan with a white stripe.
24 VDC resettable power	Red (+) & black	
24 VDC constant power	Blue (+) & gray	
Door holders	Pink (+) & gray	
Elevator capture	Black & gray	
AHU shutdown circuits	Brown & gray	
Auxiliary Power Supply for ADA strobes--supervisory trouble	Pink & Tan	
Telephone Jacks Call in circuit/supervisory	Black & Blue	
Telephone jack/talk circuit	Red & black twisted shielded	FPL #16 gauge with a drain (drain to be one gauge smaller, #18) 105 degrees/ 300V

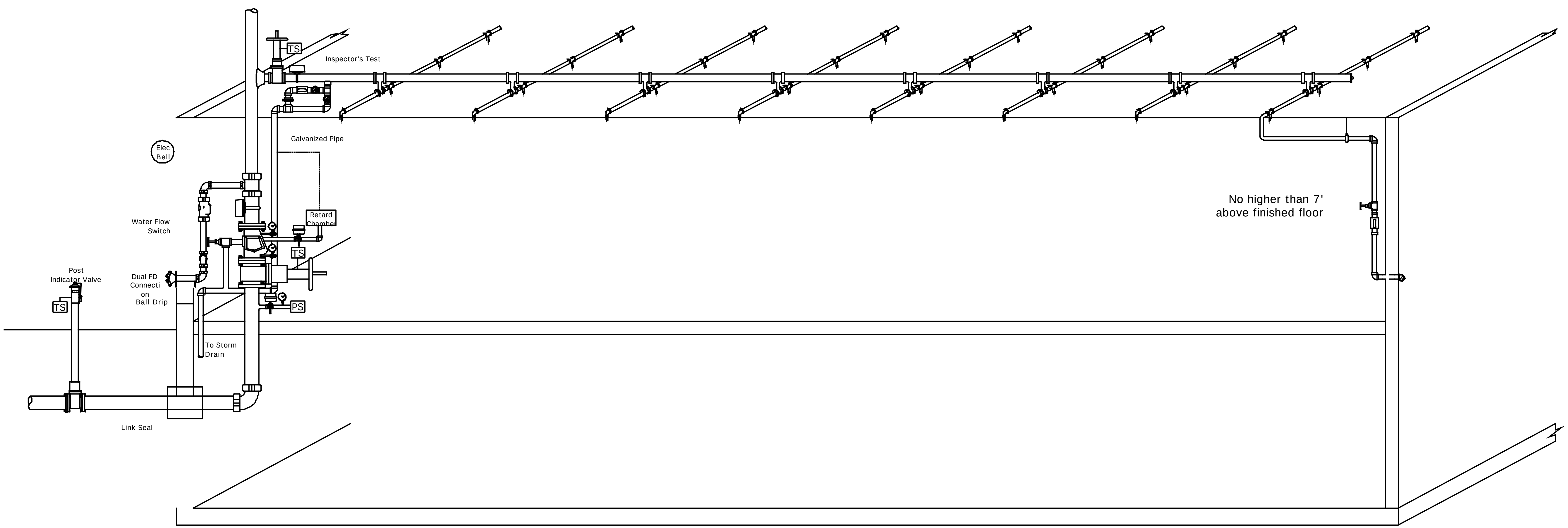
<u>Commissioning and testing</u> (Reference NFPA 25, 72)

1. All fire alarm systems shall be UL certified. Certifying company shall not be the supplying or installing company.
   Use NFPA 24 for under ground water mains
   Use NFPA 20 for fire pumps
   Use NFPA 13 for building sprinkler systems
   Use ANSI A17.1 for Elevator Recall
   Use NFPA 110 for Emergency & standby electrical systems

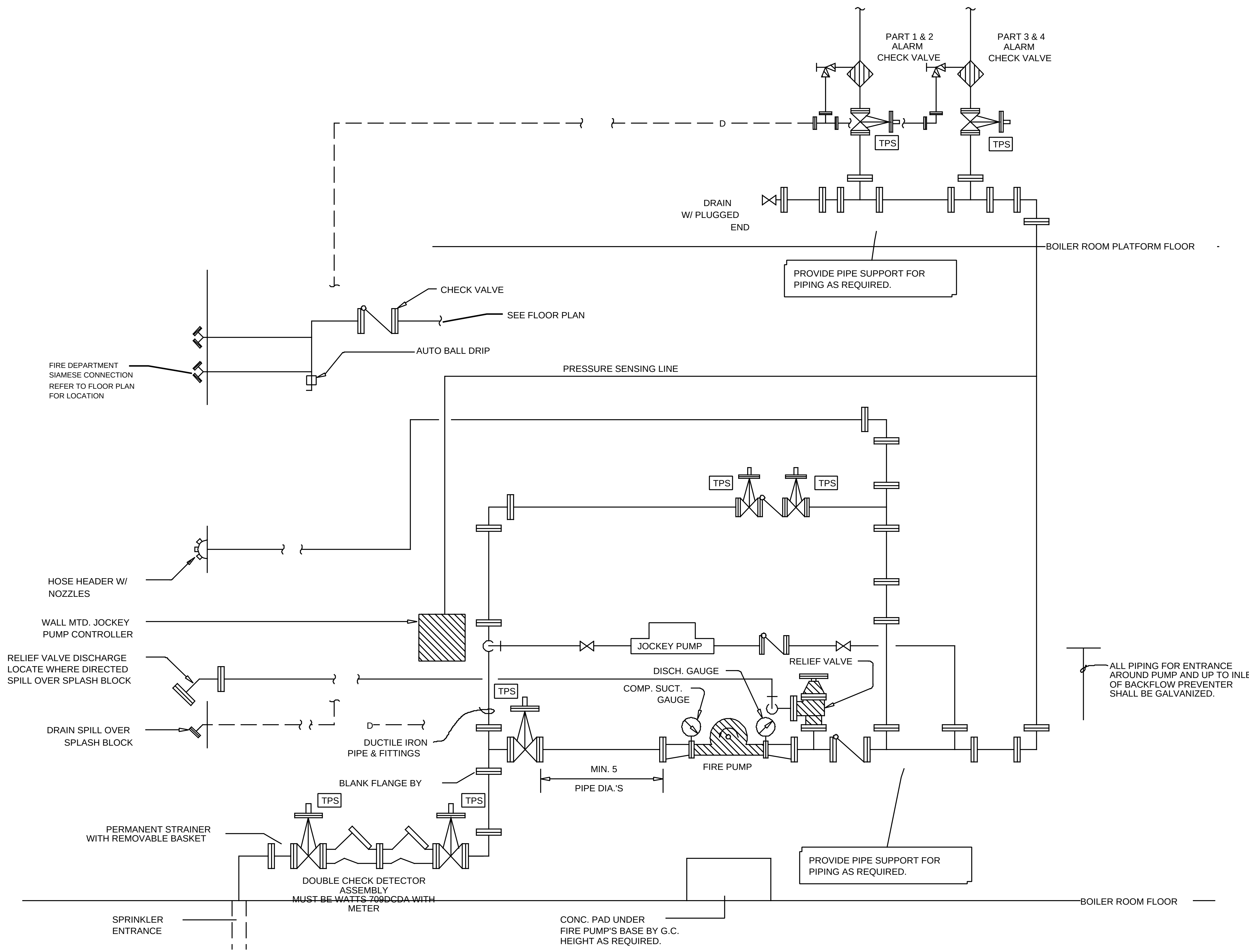
<u>Practices and Procedures</u>

a. Follow NFPA 241 during construction.
b. Fire protection equivalency shall be maintained in building renovations.
c. Prepare narrative & sequence of operation as required by MSBC Section 903 for all fire protection systems.
d. MIT shutdown notification procedure shall be followed whenever any fire protection system is to be impaired.


A
B
A
B
eolr
Terminal Can
Junction Box
Tamper Switch
Water Flow
Smoke Detector
P
Pull Station
Terminal Can
Junction Box
Second
Junction Box
Terminal Can
Devices
One loop per floor
Annunciator
First
Exterior Beacon
Fire Alarm Control Panel
LCD Readout
Auto
Manual
Water
Flow
Tamper
LED's
Campus Loop Interface
Jack Out
Printer
Batteries (Power Supply UPS)
Return Loop


TS
Inspector's Test
Galvanized Pipe
Elec Bell
Retard Chamber
Water Flow Switch
TS
Post Indicator Valve
Dual FD Connection Ball Drip
TS
PS
To Storm Drain
Link Seal
No higher than 7'
above finished floor

(back to text)



SCHEMATIC DETAIL OF PIPING TO AND FROM FIRE PUMP

SCALE: NOT TO SCALE

(back to text)

Sprinkler System Design Criteria

Occupancy	System Type	Design Flow Density (gpm/sq.ft)	Design Area (sq./ft)	Sprinkler Head Temperature Rating (☜F)	Hose Stream Demand (GPM)	Flow Duration (minutes)
Light Hazard (offices, corridors, dormitory rooms, kitchens, dining areas, hospitals)	wet	0.10	1,500	any	250	60
	dry	0.10	1,950	any	250	60
Ordinary 'Hazard Retail stores and similar building (including theaters and auditoriums) (excludes exhibit halls w/ unusually high ceilings)	wet	0.15	2,500	any	250	60
	dry	0.15	3,500	any	250	60
Labs (containing less than 70 gallons of flammable liquids)	wet	0.15	2,500	any	250	60
Labs (containing 70 gallons or more of flammable liquids)	wet	0.20	2,000	any	250	60

(next)

Sprinkler System Design Criteria

Occupancy	System Type	Design Flow Density (gpm/sq.ft)	Design Area (sq./ft)	Sprinkler Head Temperature Rating (☜F)	Hose Stream Demand (GPM)	Flow Duration (minutes)
Library Stacks	per NFPA 231 and FM data sheets 2-8N and 8-9					
Parking Garage	dry	0.15	3,500	any	250	60
Mechanical Rooms	wet	0.20	3,000	286	500	60
	dry	0.20	4,000	286	500	60
Mechanical Rooms						
Containing no oil-filled electrical equipment or other flammable liquids or gases	wet	0.15	2,500	any	250	60
	dry	0.15	3,500	any	250	60
Electrical Rooms Containing oil insulated transformers						
	wet	0.20	Room Area	any	250	60
Basement Storage Area	wet	0.20	2,500	165 or 286 ELO sprinklers	250	60

(next)

Sprinkler System Design Criteria

Occupancy	System Type	Design Flow Density (gpm/sq.ft)	Design Area (sq./ft)	Sprinkler Head Temperature Rating (☜F)	Hose Stream Demand (GPM)	Flow Duration (minutes)
Emergency Generator Rooms	wet	0.20	Room Area	any	250	60

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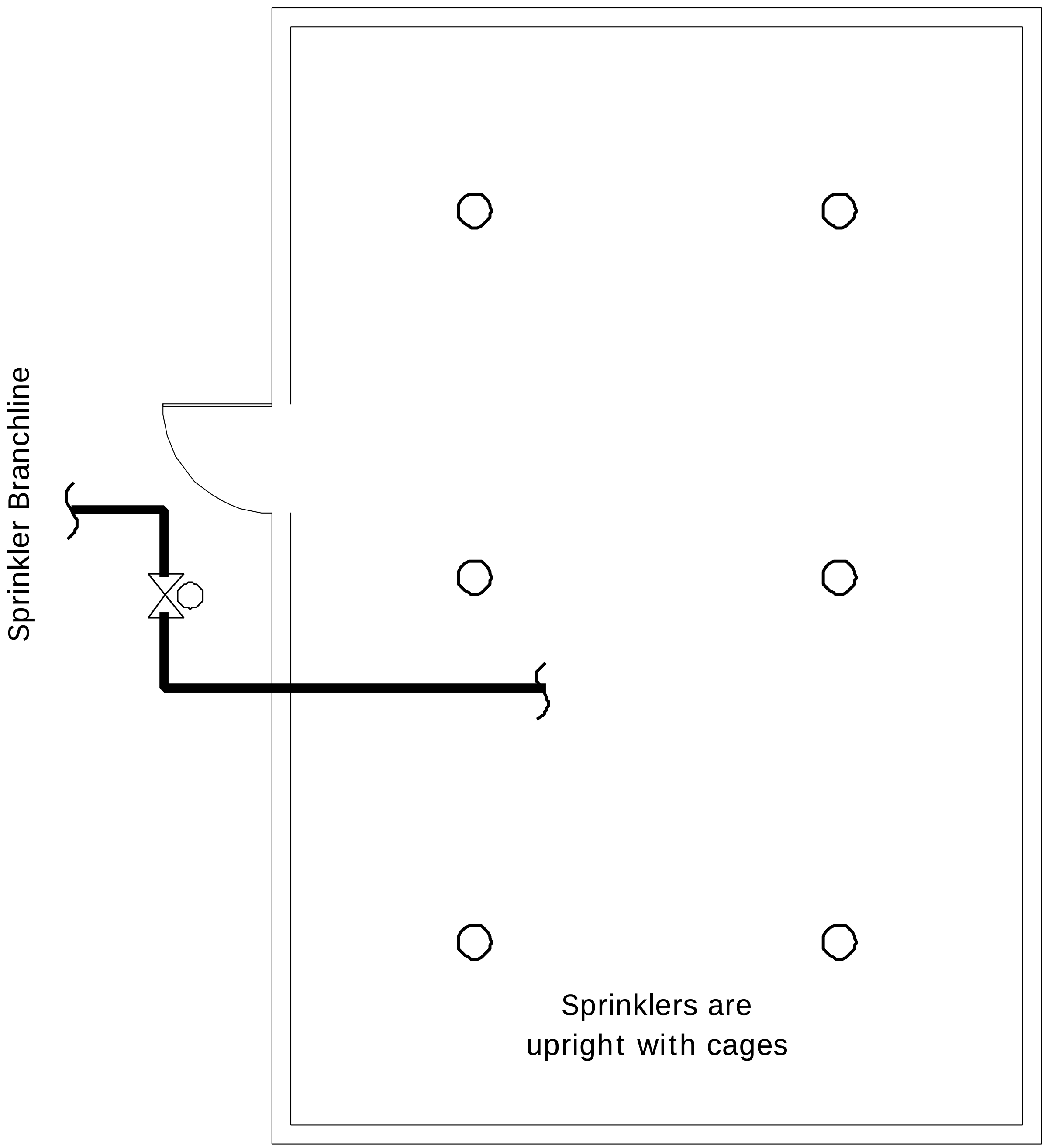
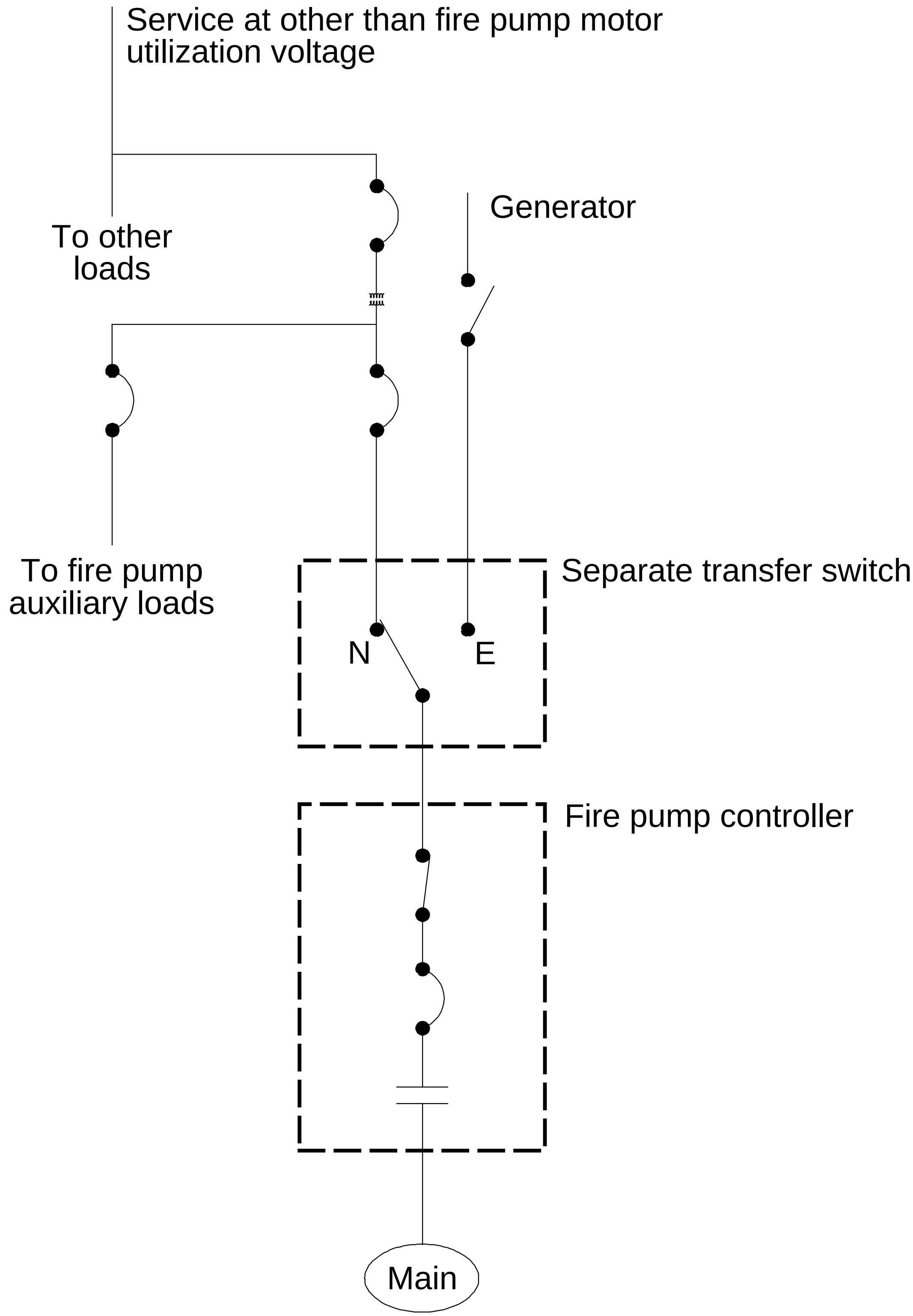


Valve monitored by a tamper switch

ELECTRIC ROOM



ELECTRIC PUMP TRANSFER

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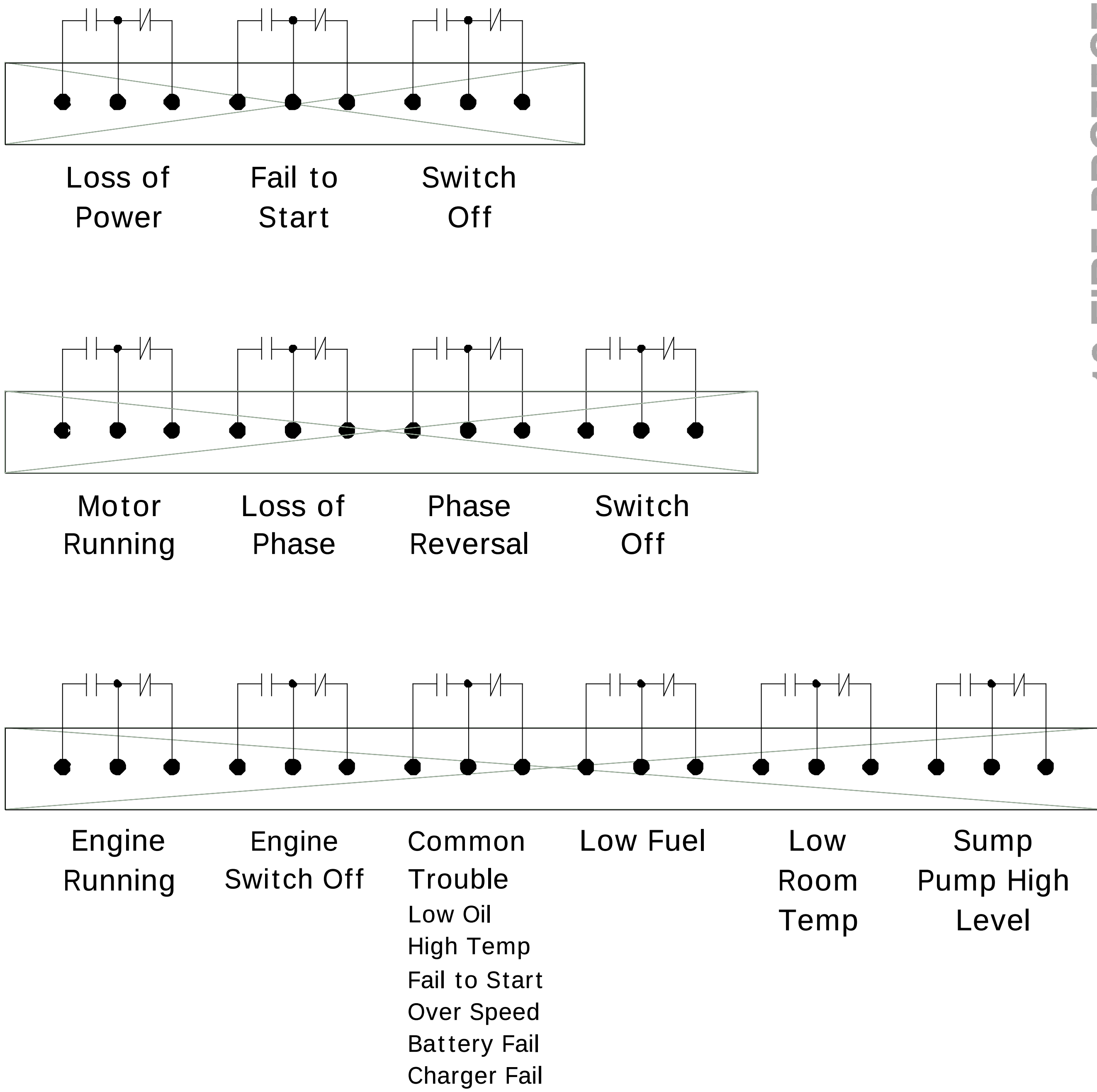

Electric Fire Pump Controller Required Signals

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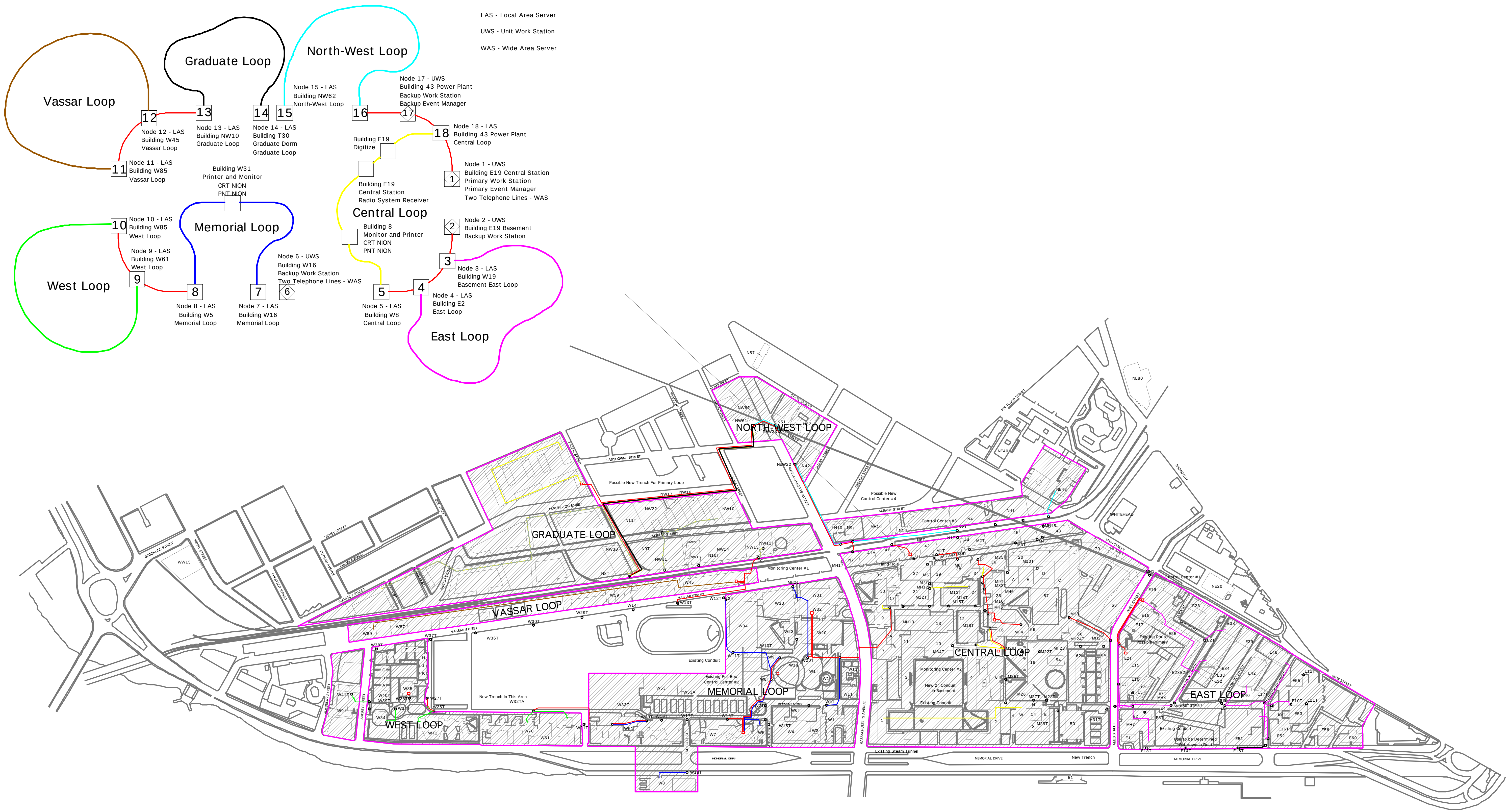

FIRE ALARM MONITORING

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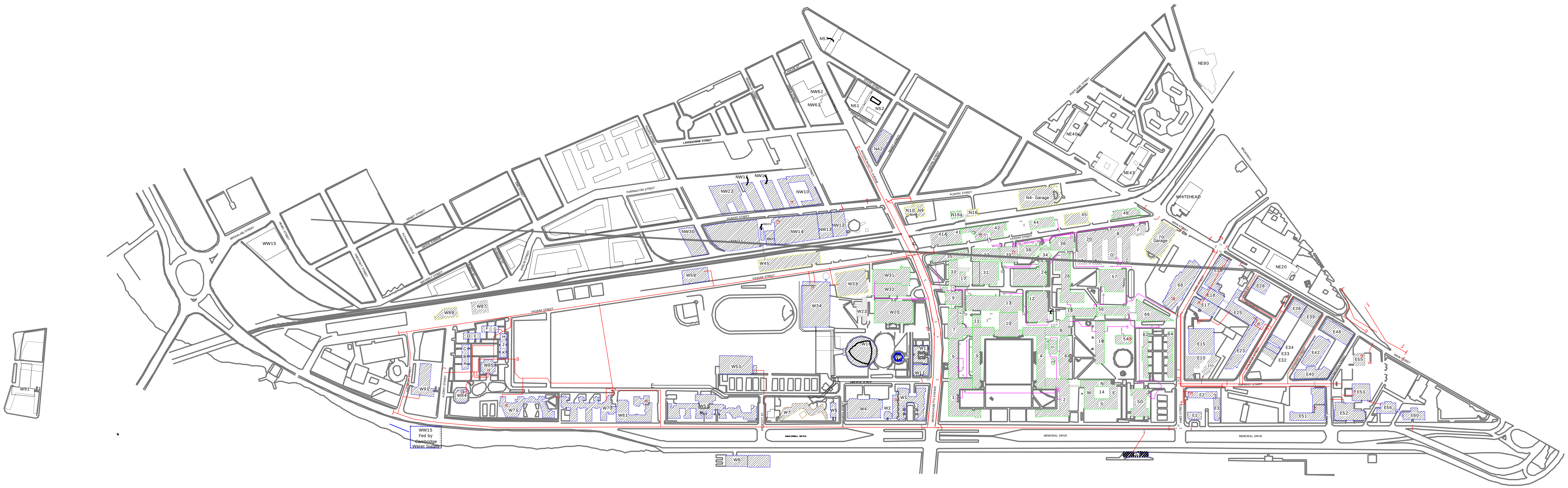
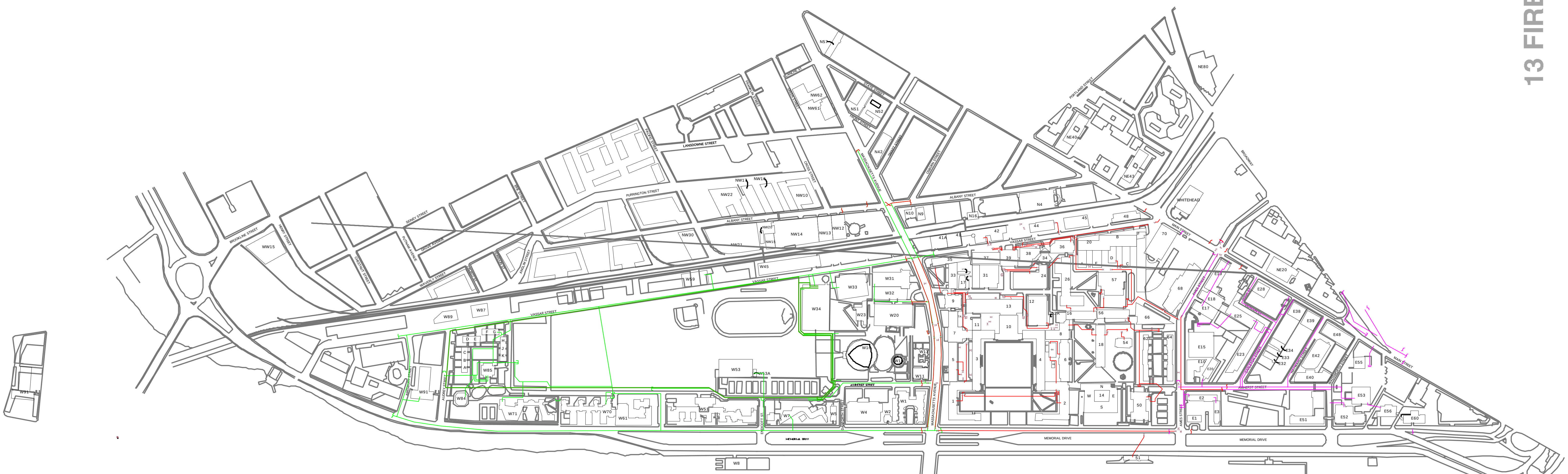


BUILDING FEEDS



WATER LOOPS

(back to text)

Products

(This section to be added)

Green Design

(This section to be added)

Operations

(This section to be added)

Environmental Health & Safety

(This section to be added)

Institute Spaces
Art, Architecture & Preservation

(This section to be added)

Laboratory Services

(This Section to be ADded)

Design Review Checklist

Design Review Check List

The Design Consultant is responsible for filling out and submitting this checklist at every phase of design as a guide for design review by MIT Facilities.

SCHEMATIC DESIGN

___ 1. Review of applicable codes and regulations
___ 2. System descriptions and alternative concepts
___ 3. Outline specification and catalog cuts
___ 4. Statement of Probable Costs

Signed:____(Fire Protection Design Consultant)

DESIGN DEVELOPMENT

___ 1. List of all subsystems
  ___ Fire Detection/Alarm System
  ___ Automatic Sprinkler Suppression System
  ___ Deluge Suppression System
  ___ Pre-Action Suppression System
  ___ Dry Pipe Suppression System
  ___ Fire Pump
  ___ Gaseous Suppression System
  ___ Dry Chemical Suppression System
  ___ Kitchen Hood Suppression System
  ___ ______________________________
  ___ ______________________________
  ___ ______________________________
  ___ ______________________________

___ 2. Basis of Design Narrative
___ 3. Calculations
  ___ a. Battery calculations
  ___ b. Hydraulic Calculations

___ 4. System descriptions
  ___ a. Fire Alarm Riser diagram
  ___ b. Sprinkler Riser diagram

Signed:____(Fire Protection Design Consultant)

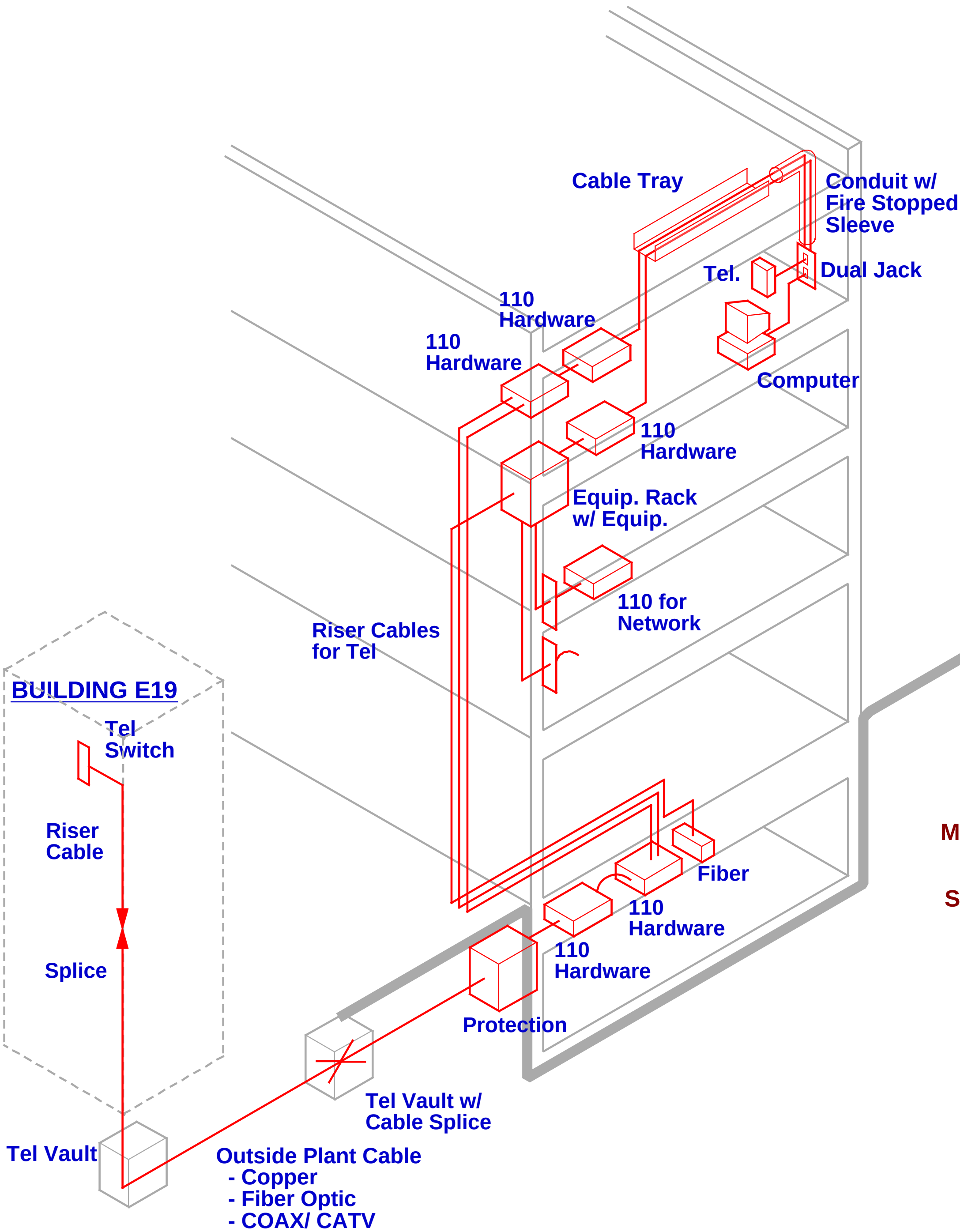
CONTRACT DOCUMENTS

___ 1. List of changes from Design Development documents
___ 2. List of Add/Delete alternates
___ 3. 100% Contract Documents

___ 4. Statement of Probable Costs
___ 5. Fire Protection System Test Results
___ 6. Final List of all subsystems

___ Fire Detection/Alarm System
___ Automatic Sprinkler Suppression System
___ Deluge Suppression System
___ Pre-Action Suppression System
___ Dry Pipe Suppression System
___ Fire Pump
___ Gaseous Suppression System
___ Dry Chemical Suppression System
___ Kitchen Hood Suppression System
___ ______________________________
___ ______________________________
___ ______________________________
___ ______________________________

Signed:____(Fire Protection Design Consultant)


Cable Tray
Conduit w/ Fire Stopped Sleeve
Tel.
Dual Jack
110 Hardware
110 Hardware
Computer
110 Hardware
Equip. Rack w/ Equip.
110 for Network
Riser Cables for Tel
BUILDING E19
Tel Switch
Riser Cable
Splice
Fiber
110 Hardware
110 Hardware
Protection
Tel Vault w/ Cable Splice
Tel Vault
Outside Plant Cable
- Copper
- Fiber Optic
- COAX/ CATV

Mission Statement

The purpose of this section is to provide guidance for architects and engineers about the space requirements for telecommunications facilities for new academic and research buildings as well as for buildings undergoing substantial renovation at MIT.

The designers should recognize that information technology and communication infrastructure is for all of MIT and affects everyone.

Installations should be designed with the consideration that the physical spaces need to be flexible; sufficient space must be provided for two generations of racks, equipment, and cabling to allow for a cutover of systems. It should be noted that an operating life of equipment is 1-4 years, while the operating life of the cabling is 5-10 years.

The design will incorporate access to equipment that will allow for ease of maintenance, repair and replacement, and day-to-day operation.

The designers should recognize that information technology changes rapidly and that the MIT infrastructure must be prepared to change with it.

Top Ten List of Common Information Systems Design Issues

(not prioritized)

1. The tel/data rooms should be stacked.
2. The tel/data rooms should be accessible at all times (24/7) from a public corridor, i.e. not within a lab or restricted space, or within a bathroom.
3. The tel/data rooms require climate controls and emergency power.
4. The tel/data rooms should allow for expandability and future growth.
5. Equipment, cables and pathways need to be accessible after the installation.
6. All jacks/pathways should run to a tel/data room located on the same floor.
7. The MIT standard for CATV is 1 Ghz
8. The total cost of ownership (installation and ongoing maintenance) must be considered.
9. Follow established telecommunications and data standards
10. Check in and review progress with the I/S organization.
11. Follow the MIT Code of Design.

Special MIT Design Requirements

MAJOR SPACE REQUIREMENTS

1. Service Entrance: the location where telecommunications lines or cables enter the building.
2. Main Terminal Room: the location for incoming cables to interface with the riser system.
3. Riser System: in multi-story buildings, provides vertical distribution from the main terminal room to floors above.
4. Apparatus Closet : is a location for cable terminals as well as relay circuitry and power equipment for both telephone (voice) and data communication station apparatus.
5. Distribution Cables: extend from Apparatus Closets or satellite locations over ceilings or under floors and terminate in appropriately spaced service fittings.

Service Entrance

1. Underground telecommunications lines or cables should be provided and located within MIT's underground duct system. New buildings typically include extensions for connecting to the underground duct system.
   a. Aerial Service may be provided under certain circumstances, particularly off-campus locations. Telecommunications lines or cables, supported on poles, may enter the building aerially. Proper safety clearances from other utility lines must be maintained. Aerial service can be converted to underground conduit where appropriate such as at building entrance points.
   b. Quantities of 4" underground ducts required for academic and research buildings are based on the planned number of working telephone lines (for both voice and data communications). One telephone line is needed for every 100 sq. ft. of usable space.

Telephone Lines	4" Conduits Required
1 – 250	1 conduit
251 - 1000	1 conduit + 1 spare
1001 - 2000	2 conduits + 1 spare
2001 - 3000	3 conduits + 1 spare
3001 - 5000	4 conduits + 1 spare
5001 - 7000	5 conduits + 1 spare
7001 - 9000	6 conduits + 1 spare

   c. Additional conduits may be needed in facilities with closed circuit TV, video, etc.
   d. Conduit should not be housed in manholes containing electrical cables.

Main Terminal Room

1. Incoming lines or cables usually run directly to a main terminal where cross-connections are made with the riser cable system that runs throughout the building. In large installations, floor-type main terminals are located in the main terminal room, sometimes called the mainframe room.
2. The following outlines the size of space required for cable terminations:

   a. Up to 40,000 sq. ft.: Wall terminals are generally mounted on??" plywood backboards, 8' high x 4' wide.

   b. 40,000 – 100,000 sq. ft.: Shallow closets: 24" deep by 6' long for 50,000 sq. ft. facilities to 24" deep by 9' long for 90,000 sq. ft. facilities

   c. 100,000 sq. ft. and up:

Total Area (sq ft)	Min. Space Required
100,000 to 150,000	8' x 10'
151,000 to 300,000	9' x 16'
301,000 to 500,000	10' x 24'

3. The typical location for the main terminal room is in the basement near the center of the riser cable distribution facilities. The main terminal room must be dry and should be provided with an adequate number of electrical outlets. Conduit should be installed to bring the cables from the service entrance to the main terminal room. When conduit is not provided, cables and supporting hardware shall be installed on walls and ceilings.
4. The main terminal room should be sprinkled.

<u>Riser System</u>

1. The riser cable system consists of the facilities for bringing cables from the main terminal room to the various floors of the building. The riser cables may be brought through riser shafts or riser conduits, depending on the type and/or size of the building. Because of horizontal dimensional characteristics of some buildings, rise cables may be distributed laterally or run both laterally and vertically.
   a. Multi-story Risers: In multi-story buildings, cables are extended vertically by means of riser shafts. An alternative is the use of riser conduit. A common method is to provide vertically stacked riser closets on each floor. These closets provide room for splicing cables, cable terminations and other equipment relating to station apparatus. When closets are not directly above each other, conduit should be provided between them.
   b. Sleeves: Slots or sleeves should be aligned for clear vertical pull of cables. Where sleeves are used, they should be at least 4” in diameter and should be extended 2” above the floor. Where slots are used, they should be 4”in width and 2” curb. Sleeves and/or slots should be located adjacent to a wall to which the cable scan be clamped for support.
   c. Use o f Shafts: Use of riser shafts assigned to telecommunications facilities should not be used for other purposes in order to prevent the possibility if interference and/or service interruptions.
   d. Quantity: The following provides a basis for deterring the number of 4” sleeves. It is based on 1 line per 100 sq. ft. of floor space.

Floor Area Served (sq ft).	Number of 4” Sleeves
Up to 50,000	2
51,000 to 100,000	3
101,000 to 300,000	4
301,000 to -500,000	5

   e. In small buildings, the riser system consists of a series of terminal cabinets connected by means of conduit. Where flush mounted cabinets are desired they are to be incorporated into the architectural design of the building.

<u>Apparatus Closet</u>

1. Apparatus closets house the cables that form the riser system. The cables are inter-connected, using connecting blocks, to relay and power equipment that provide services to various telephone systems including multi-button telephone and data communications services, as well as to the cable pairs that radiate from the closet to stations located throughout the floor. Apparatus closets that function with cable riser system and/or an underfloor raceway system are referred to as riser closets or zones closets .
   a. Limits: one apparatus closet may serve up to 36,000 sq. ft. of floor area provided the greatest distance from the equipment in the closet to any telephone on the floor does not exceed 150 linear feet. This limitation is due to the signaling requirements of the circuits serving the lamps on multi-button telephones and to the lengths of floor cables.
   b. Support: Walls of the closet should be lined with backboards of <u>??</u>” thick plywood to support the weight of relay panels and circuit units, power equipment, etc.

2. Apparatus Closet Design Issues
   a. In a walk-in closet (4’-6” minimum depth), provide clearance for the swinging apparatus mounting gate on which the relay and power equipment is typically located.
   b. The minimum depth for a shallow closet is not less than 18” deep.
   c. Minimum door heights are 80” for a 36”-deep closet and 84” for an 18”-deep closet.
   d. The minimum door width is 36”
   e. The minimum ceiling height is 90”.

f. Provide at least one ceiling light fixture with a wall switch.
g. Provide a separately-fused 20-amp circuit to 2-110 colt duplex receptacles in each closet.
h. Emergency power automatic switchover of the 110-volt duplex receptacles is recommended.
i. Apparatus closet door keying is to MIT key number 320S (the prescribed telephone closet key for academic and research buildings.
j. Following are space requirements for centralized apparatus closets based on 1 telephone per 100 sq. ft. of floor space:

Walk-In Closet (4' - 6" x 7' min.)

Sq. Ft. of Floor Area	Room Size
Up to 10,000	4'-6" x 7'
10,000 -15,000	4'-6" x 10' or 6'-6" x 7'
15,000 - 20,000	4'-6" x 13' or 9' x7'

Shallow Closet (18" deep x 6' wide min.)

Sq. Ft. of Floor Area	Total Width
Up to 5,000	6'
5,000 - 10,000	11'
10,000 -15,000	16'
15,000 - 20,000	21'

Room Equipment Enclosed in Housing

Sq. Ft. of Floor Area	Linear Ft. of Continuous Wall Area
Up to 5,000	10'
5,000 - 10,000	14'
10,000 - 20,000	28'

3. Satellite closets may be required to accommodate particularities of raceway systems, because a single apparatus closet is inadequate for users needs, or because the floor layout or configuration is irregular. Satellite closets provide cable termination facilities but do not contain relay and power equipment. Requirements for satellite closets include:

Floor Area Served (sq ft)	Total Linear Ft. of Continuous Lateral Wall Area Required
Up to 9,000	6'
9,001 - 18,000	12'
18,001 - 27,000	18'
27,001 - 36,000	24'

4. Apparatus closets, central riser closets or zone closets should be sprinkled.

Distribution Cable

1. Telephone companies and other telecommunications suppliers typically install exposed cable, wire and other back-up equipment, unless means are provided to extend cable from apparatus closets over ceilings and/or under floors. For concealed runs, MIT prefers installation of cable and wiring above suspended ceilings rather than under floors. Wiring installed above accessible ceilings is more economical, more flexible for changing room layouts, and less hazardous than fixed floor outlet fittings.
   a. The recommendation for installing wiring and cabling above suspended ceilings does not include approval of the unfortunate practice of drilling holes through a floor to gain access to the ceiling below.
   b. Service fittings or outlets should be provided in each room or space. One outlet should be provided for each required telecommunications service. For example, if an individual office, work station or laboratory position requires both a telephone and a data communications terminal, two outlets must be provided.
   c. Requirements for raceways are given in the National Electric Code.

Telephone Distribution

1. Provide primary horizontal cable trays or wire ways from the riser closets along corridors, except where there is no corridor ceiling, provide regularly spaced corridor crossover.
   a. Corridor Sleeves: Provide corridor sleeves at modular intervals.
   b. Raceways: Comply with National Electrical Code, Article 100.
   c. Poke Through Distribution: Poke through distribution from floor above to ceiling below is prohibited at MIT.
   d. Outlets: Provide at least one telecommunications outlet for each room or space, except where programmatic requirements indicated more frequent outlet spacing. Provide separate outlets for telephone and data communication.
   e. Outlets in Solid Walls: Provide recessed outlet box with cover plate, _" rigid conduit, and pull wire to above ceiling.
   f. Outlets in Hollow Walls: Provide recessed outlet box with cover plate _" rigid conduit, and pull wire through above ceiling.
2. Provisions should be made in lobbies or general public areas for coin telephone and/or MIT telephones to be flush mounted or recessed into a wall.
   a. Typical wall openings for these telephones are listed below. However, these dimensions are subject to change. At the start of each project, obtain a template from the Telecommunications Department for each type of phone to be installed.

	Coin Telephone	MIT Telephone
Vertical Dimension	23"	11 _"
Horizontal Dimension	16 _"	8 5/8"
Depth	7"	2 _"

   b. Provisions should be made to allow wiring for these telephones without exposing the wire.
   c. Specification requirements exist for the locations of all telephones for compliance with the accessibility guidelines of the ADA ad the Massachusetts Architectural Access Board. These requirements must be reviewed and incorporated into the design of the building or renovations.
3. Provide one handicapped accessible public coin telephone and one handicapped accessible MIT telephone in each lobby. Recess public and MIT telephones and conceal all wiring.
4. Provide emergency telephones in all elevators with ring down circuit connected directly to MIT Operations Center.

Products

(This section to be added)

Green Design

(This section to be added)

Operations

(This section to be added)

Environmental Health & Safety

(This section to be added)

Institute Spaces
Art, Architecture & Preservation

(This section to be added)

Laboratory Services

(This Section to be ADded)

Design Review Checklist

(This section to be added)

SECTION 13090 - RADIATION PROTECTION

1. **Radiation Protection:** The Designer should contact M.I.T. Environmental Medical Service, Radiation Protection Office, through the M.I.T. Project Manager early in the design process.

   A. Proper radiation protection and shielding cannot be determined without a complete understanding of the radiation type and strength to be protected against.

   B. M.I.T. EMS Radiation Protection Office must approve all protection and shielding materials used.

2. **Radiation Protection Materials:** Special lead lined construction materials are available: drywall, concrete masonry, steel and wood doors, door hardware, hollow metal frames, leaded glass, and other materials. Manufacturers and sources of these materials include the following:

   A. A & L Lead Company, Inc., Rome, Georgia

   B. Nelco, New England Lead Burning Company, Woburn, Massachusetts

   C. Radiation Protection Products, Inc., College Grove, Tennessee

   D. Ray-Bar Engineering Corporation, Azusa, California

END OF SECTION

DIVISION 14 - Conveying Systems

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SECTION 14100 - DUMBWAITERS

1. **Limitations:** Dumbwaiters are not elevators and are not intended for moving people, only materials. Consequently, dumbwaiters must have cars which are too small to reasonably accommodate people.

   A. Capacity: 500 pounds maximum.

   B. Car Floor Area: 9 square feet maximum.

   C. Car Height: Four feet maximum; the space may be divided by shelves.

   D. Car Interior: Provide stainless steel interior for dumbwaiters used for food service and food handling.

2. **Interlocks:** Dumbwaiters, like elevators, need hoistways and interlocks on hoistway doors to prevent movement of the dumbwaiter car when hoistway doors are open and to prevent opening of the hoistway doors when the dumbwaiter is not at that stop.

3. **Motor Location:** Dumbwaiters are usually electric powered, cable supported, and moved by cable on a winding drum. The motor and drum can be located at either the bottom or top of the hoistway. Safety devices on dumbwaiters resemble the original safety devices used on elevators and are not a sophisticated or as safe as those currently used on elevators.

   A. Leveling Height: Dumbwaiters can stop and level at floor height for cart loads [like a typical library application] or can stop at countertop level [for most materials on trays]. For floor leveling dumb-waiters the machinery is usually at the top of the hoistway. For counter level dumbwaiters the machinery is usually at the bottom of the hoistway.

   B. Preferred Motor Location: Since it is usually much easier to access and maintain the machinery when located near the bottom of the hoistway, locate the machinery adjacent to the hoistway at the bottom of the hoistway even when using floor leveling dumbwaiters.

4. **Controls:** Dumbwaiter controls typically have send functions to direct the dumbwaiter to specific levels and call functions to recall the dumbwaiter to the call level. You should specify if there is a home landing to which the dumbwaiter automatically returns when not in use. Home landings are not typically required and will not be provided unless specified.

5. **Dumbwaiter Maintenance:** M.I.T. will contract with elevator [dumbwaiter] maintenance contractors to provide regular monthly service. For new work, specify that only machines, controls, and components which can be maintained, repaired, or replaced by any competent elevator [dumbwaiter] service provider can be used. Do not permit the installation of any dumbwaiter component which can only be serviced from one source. There must be fair competitive bidding on dumbwaiter maintenance work at M.I.T.

   A. Initial Dumbwaiter Maintenance: Construction contracts for dumbwaiter installations must include complete, comprehensive one year warranty and service covering all needed maintenance and repair.

   B. Continuing Dumbwaiter Maintenance: M.I.T. will obtain bids and award continuing maintenance contracts [five year contracts renewable annually]. Dumbwaiter systems must be generic enough to permit maintenance by any qualified service agency so that M.I.T. can obtain competitive bids on service contracts.

END OF SECTION

SECTION 14200 - ELEVATORS

1. **General:** Elevator modifications require extraordinary long lead times (often 16 - 20 weeks after shop drawing approval). In an effort to reduce the length of time, many elevator subcontractors will request a waiver of the shop drawings phase. Except in the rarest of cases, this is not recommended. The schedule should be reviewed and modified early in the project to accommodate the lead times for this work. It is strongly recommended that M.I.T. Electrical Services review shop drawings for all elevator installations.

2. **Elevator Type:** Typically, provide electric overhead traction-type elevators in all new buildings [100-150 fpm for low-rise and above 150 fpm for mid and high rise]. Holeless hydraulic elevators may be used in one, two or three stop installations. M.I.T. has experienced significant difficulties with the installation and maintenance of in-ground hydraulic pistons and prefers not to use them. The elevator type should be chosen based on required elevator performance and cost and in conjunction with the M.I.T. Electrical Services Department through the M.I.T. Project Manager.

3. **Accessibility Requirements:** Both the ADA and AAB have very specific requirements for all of the elements of performance for passenger elevators. The Designer should thoroughly review these requirements before writing the specifications to assure that full compliance will be achieved.

4. **Elevator Performance:** The following guidelines generally apply to acceptable elevator performance. Most projects with elevators will need more than one elevator to provide acceptable performance and redundancy.

   A. Maximum Waiting Time After Calling Elevator: 30-35 seconds.

   B. Five Minute Handling Capacity: 12% of building population based on building code occupancy rates.

5. **Machine Room Lighting:** All machine room lighting shall be 4' fluorescent fixtures with protective covers over the bulbs. Do not install incandescent lighting in the machine room.

6. **Freight Elevators:** Provide freight elevators in all new buildings, where appropriate. Provide minimum 60" wide by 80" high hoistway access doors and provide minimum 90" deep by 84" wide cab platform.

7. **Passenger Elevators:** Provide elevators to meet CMR 524 Massachusetts State Elevator Code including requirements for barrier-free accessibility and medical emergency elevators [CMR 524, Article 17.40]. The requirements for accessibility are stringent with regard to size and accessories and must be reviewed early in the project to avoid costly redesign or change orders later.

   A. During renovations or alterations of an elevator cab, M.I.T. may choose to provide additional accessories or equipment to comply with anticipated code revisions. Consult with the M.I.T. Electrical Services Department through the M.I.T. Project Manager to determine and appropriate scope of work.

7\. **Elevator Hoistway Access:** Provide special locked elevator cab egress doors and hoistway doors to discourage unauthorized access into elevator hoistways. It is very important to impede mountain climbing and thrill rides within the elevator hoistways.

8\. **Elevator Maintenance and Warranty:** M.I.T. will contract with elevator maintenance contractors to provide regular monthly elevator service. For new elevator work, specify that only machines, controls, and components which can be maintained, repaired, or replaced by any competent elevator service provider can be used. Do not permit the installation of any elevator component which can only be serviced from one source. There must be fair competitive bidding on elevator maintenance work at M.I.T.

A. Initial Elevator Maintenance and Warranty: Construction contracts for elevator installations must include complete, comprehensive one year warranty and service covering all needed maintenance and repair.

B. Continuing Elevator Maintenance: M.I.T. will obtain bids and award continuing maintenance contracts [five year contracts renewable annually]. Elevator systems must be generic enough to permit maintenance by any qualified service agency so that M.I.T. can obtain competitive bids on service contracts.

C. State of the Art: M.I.T. prefers State of the Art equipment of the highest quality, however proprietary software and maintenance is not allowed.

9. **Controllers:** Elevator controllers should be designed to incorporate requirements for up-to-date fire alarm, elevator recall and firefighter's service (Phases 1 - 4). In renovations, where practicable, controllers should be upgraded to include the capacity for these elements where they do not already exist.

10. **Door Edges:** M.I.T. prefers the use of non-mechanical, motionless safety edges such as "Panaforty" Light Ray Assembly. Mechanical safety edges are a source of constant maintenance difficulties.

11. **Elevator Cab Flooring:** M.I.T. typically uses round low profile raised profile rubber tile flooring; see Section 09650 for flooring requirements. Specifications must be clear about floor finish responsibility since elevator subcontractors often do not consider the finished floor as part of their responsibility.

12. **Elevator Cab Walls:** M.I.T. has had success with Kydex wall panels [Kleerdex Company 1-800-325-3133] and stainless steel. Wood veneer does not work well and is discouraged. Plastic Laminate panels may be acceptable.

13. **Telephones:** All M.I.T. elevators must have a rough-in for telephone in elevator cabs and traveling cables. Telephone wiring should terminate in clearly labeled junction box in elevator machine room. Telephone instrument will be provided by the elevator contractor. Telephones must be accessible to individuals with disabilities. It must be operable without tight grasping, pinching or twisting of the wrist. Hands-Free phones built into the gang station work well for this purpose. Also, the phones must not require voice communication to signal trouble to facilitate use by those with hearing and speech impairments. Review additional requirements in the ADA and AAB. Eliminate the use of telephones inside cabinets. When removing or replacing existing elevator hands-free phones, return phones to the M.I.T. Electrical Services Department.

14. **Lighting:** Lighting in elevator cabs must be simple to maintain. Lamps must be easily accessible.

15. **Emergency Lighting:** is required and must meet the minimum requirements of the Elevator Regulations.

16. **Ventilation:** is required and must meet the minimum requirements of the Elevator Regulations.

17. **Keying:** Keying for elevator must be determined through the M.I.T. Project Manager. Key cores may be provided by M.I.T. for installation by Contractor.

18. **Signs:** Provide signs that indicate that in the event of a fire, use the stairs, not the elevator. The State Elevator Regulations are very specific about the size and wording of this sign. Also provide the State Elevator ID Number and Certificate information incorporated into the gang station. Capacity plates must also be provided when they do not exist and maintained or replaced where existing.

19. **Floor Number Designations:** Specify in accordance with the requirements of the applicable codes and regulations including the ADA and AAB. Typically, they are required on the car operating panel adjacent to the floor call buttons and on each side of the hoistway entry jambs.

    A. Car Operating Panel: M.I.T. prefers these symbols and designations be integral with the car operating panel. However, in some retrofit conditions applied designations will be required. If used, specify appropriate adhesive be used to provide a permanent installation.

    B. Hoistway Entry Jambs: These must be permanently mounted to the face of the jamb on each side of the hoistway entrance. Because of the condition of some existing jambs, the peel-off, adhesive backed designations pop off. The Designer must specify the appropriate adhesive to provide a permanent installation or require mechanical fastener such as rivets. When specifying rivets, attention should be paid to the finish of the rivet relative to the finish of the designation.

20. **Buttons:** All interior cab and hall call buttons must be vandal-proof. When specifying new hall call buttons, make sure to require metal blank-off plates in the button escutcheons where future knock-outs for firefighter's key switches are provided. Plastic button-type blank-off plates are not acceptable.

21. **Directional Lanterns and Gongs:** Gong volume should be adjustable to allow M.I.T. the flexibility to accommodate varying requirements for occupants adjacent to the elevator landings. Lanterns affixed to the car jamb may be substituted where the installation of lanterns at each floor are not possible or practical.

22. **Car Operating Panels:** When providing new car operating panels provide integral raised characters and Braille designations for each public command function. Integrate digital car position indicators, emergency lighting and emergency communications devices where applicable. All panels should be hinged to open for maximum service access. While the locations of car operating panels is governed by applicable codes and regulations, the Designer should consider the location relative to serviceability as an additional criteria.

23. **Wiring Methods:** All existing wiring to be altered shall be replaced back to the nearest junction box and re-terminated on marked terminal strips. New cabled wire shall be used to rewire all car operating stations. All spliced cables and wires shall be joined on terminal strips or with approved butt spices. No free air wire nuts shall be used. All new cables and wires shall be marked per the new wiring diagrams or per the existing designations.

24. **Cable Capacity:** The Designer must confirm, with the M.I.T. Electrical Services Department, if there is extra capacity on the existing traveling cables prior to specifying work. If not, then the Designer must specify the need for additional cables to serve the additional functions required.

25. **Coordination:** The accessibility and other regulations have limited flexibility with regard to locations of elements such as hall call buttons and signs. Careful review in the design and shop drawing phases will eliminate many of the problems.

26. **As-Built Documents:** As - Built wiring diagrams for all changes must be provided as part of the work. M.I.T. requires all elevator changes affecting any function or machine room equipment to be documented by the Elevator Subcontractor.

   A. Record Drawings must be first class, easily readable, carefully drafted reproducible drawings produced by carefully and accurately redrafting the original wiring diagrams and/or equipment diagrams to clearly show all deviations from the original drawings, the precise location of each item of work, and all field changes. Record Drawings must be submitted to and approved by M.I.T. as a prerequisite to final payment to the Contractor.

      1) Electronic Documents: When required by the M.I.T. Project Manager and/or the CAD System Administrator, provide electronic copies of all as-built record documents, both drawings and specifications. Drawings shall be AutoCAD compatible and specifications and written documents shall be Microsoft Word compatible. For more detailed information on preparation and format of AutoCAD drawings, contact the Physical Plant CAD System Administrator through the M.I.T. Project Manager.

END OF SECTION

SECTION 14400 - WHEELCHAIR LIFTS

1. **Wheelchair Lifts:** Wheelchair lifts should only be used to provide access for persons with disabilities in existing buildings. New buildings should not rely on wheelchair lifts to meet codes and should be designed to be inherently accessible or accessible with elevators. The Architectural Access Board allows lifts as a variance only. The ADA does allow wheelchair lifts. The requirements are very specific and stringent and must be reviewed early in the design phase of the project to avoid difficulties later on.

   A. Wheelchair Lift Locations: Locate lifts inside buildings in a weather-protected location. M.I.T. does not allow the installation of wheelchair lifts in exterior applications.

2. **Wheelchair Lift Types:** There are basically three types of wheelchair lifts:

   A. Vertical Wheelchair Lifts: [Type currently used at M.I.T.] Lift moves only vertically. Travel limit is about 12 feet and capacity is usually about 500 pounds. Vertical wheelchair lifts have the potential for crushing someone under the raised platform and must be equipped with safeties, limits, guardrails, gates, and skirts.

   B. Straight Stair Wheelchair Lifts: [Not currently in use at M.I.T.] Lift moves straight up stair from landing to landing [diagonally when stair is viewed in elevation]. These often fold against the wall when not in use and are supported by a structural steel rail/track system which can be wall supported or floor supported.

   C. Stair Following Wheelchair Lifts: [Not currently in use at M.I.T.] Lift follows stair rail or wall so that lift can curve around corners and landings, and travel past an intermediate landing. These may fold against the wall when not in use and are supported by a structural steel tube track system which encloses a cable [which permits the curves to be negotiated]. The track can be wall, rail, or floor supported.

3. **Stair Egress:** Wheelchair lifts installed in a stair can reduce the egress clearance; verify the egress requirements before obstructing the stair with a lift.

4. **Wheelchair Lift Controls:** Wheelchair lifts at M.I.T. must be locked to prevent unauthorized use or use as material handling systems and furniture moving systems. The Elevator Regulations currently require a key type locking mechanism which is incompatible with the requirements of the ADA. When specifying a lift, the Designer must obtain a variance from the local authorities in order to provide an electronic key pad in lieu of a lock and key. Coordinate the lift and the key pad with the Electric Shop.

   A. The MAAB often requires that lifts be accompanied by an intercom and bell that will ring to an occupied location. The purpose is to allow visitors without keys or access codes to notify someone that assistance is required. M.I.T. prefers to use a hands-free intercom connected with Campus Police for this function. It is recommended that this information be stipulated on the variance form when applying to the AAB.

5. **Wheelchair Lift Maintenance and Warranty:** M.I.T. will contract with Wheelchair Lift maintenance contractors to provide regular maintenance service. For new work, specify that only machines, controls, and components which can be maintained, repaired, or replaced by any competent Wheelchair Lift service provider can be used. Do not permit the installation of any component which can only be serviced from one source. There must be fair competitive bidding on Wheelchair Lift maintenance work at M.I.T.

A. Initial Maintenance and Warranty: Construction contracts for Wheelchair Lift installations must include complete, comprehensive one year warranty and service covering all needed maintenance and repair.

B. Continuing Maintenance: M.I.T. will obtain bids and award continuing maintenance contracts [one year contracts renewable annually].

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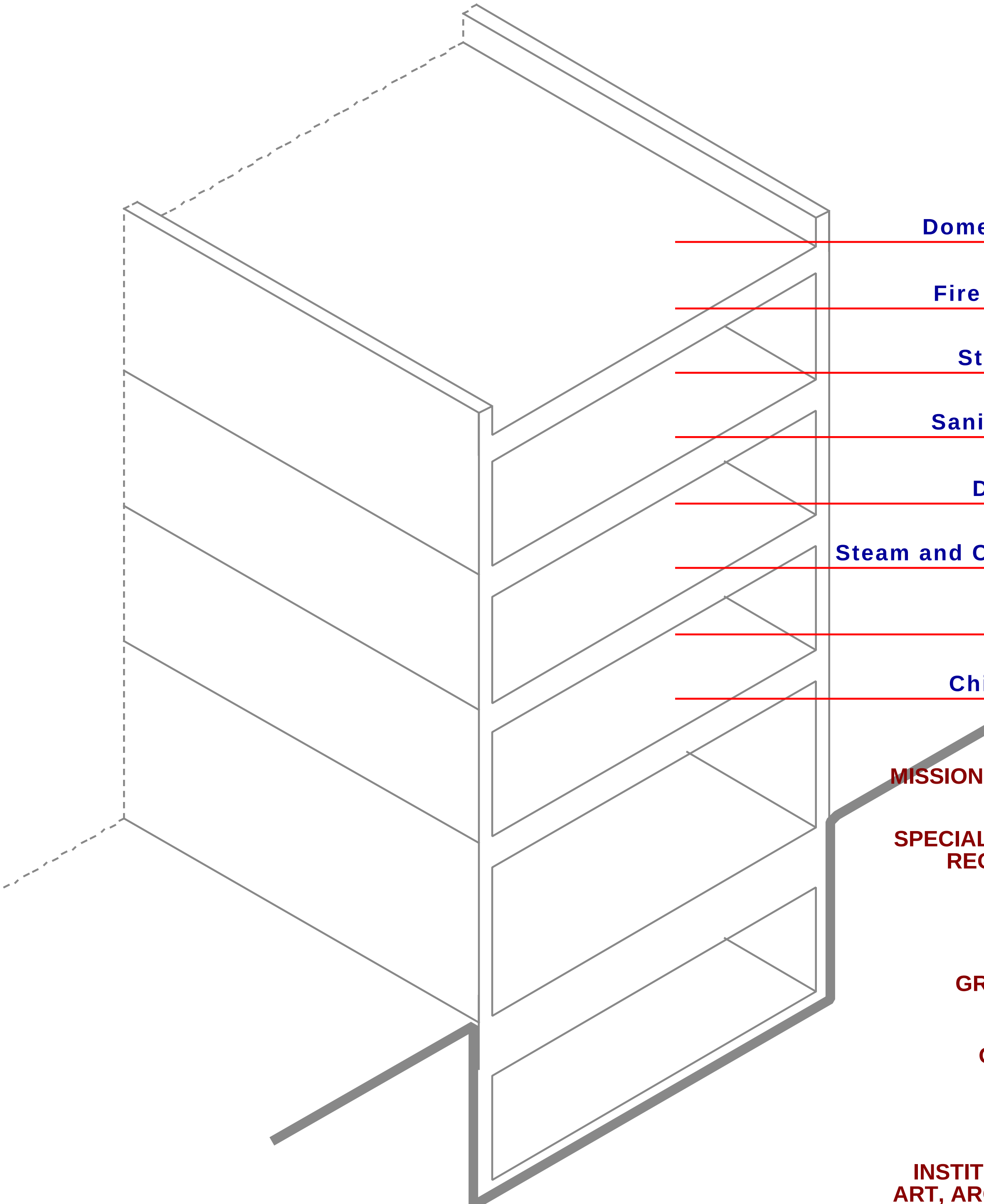
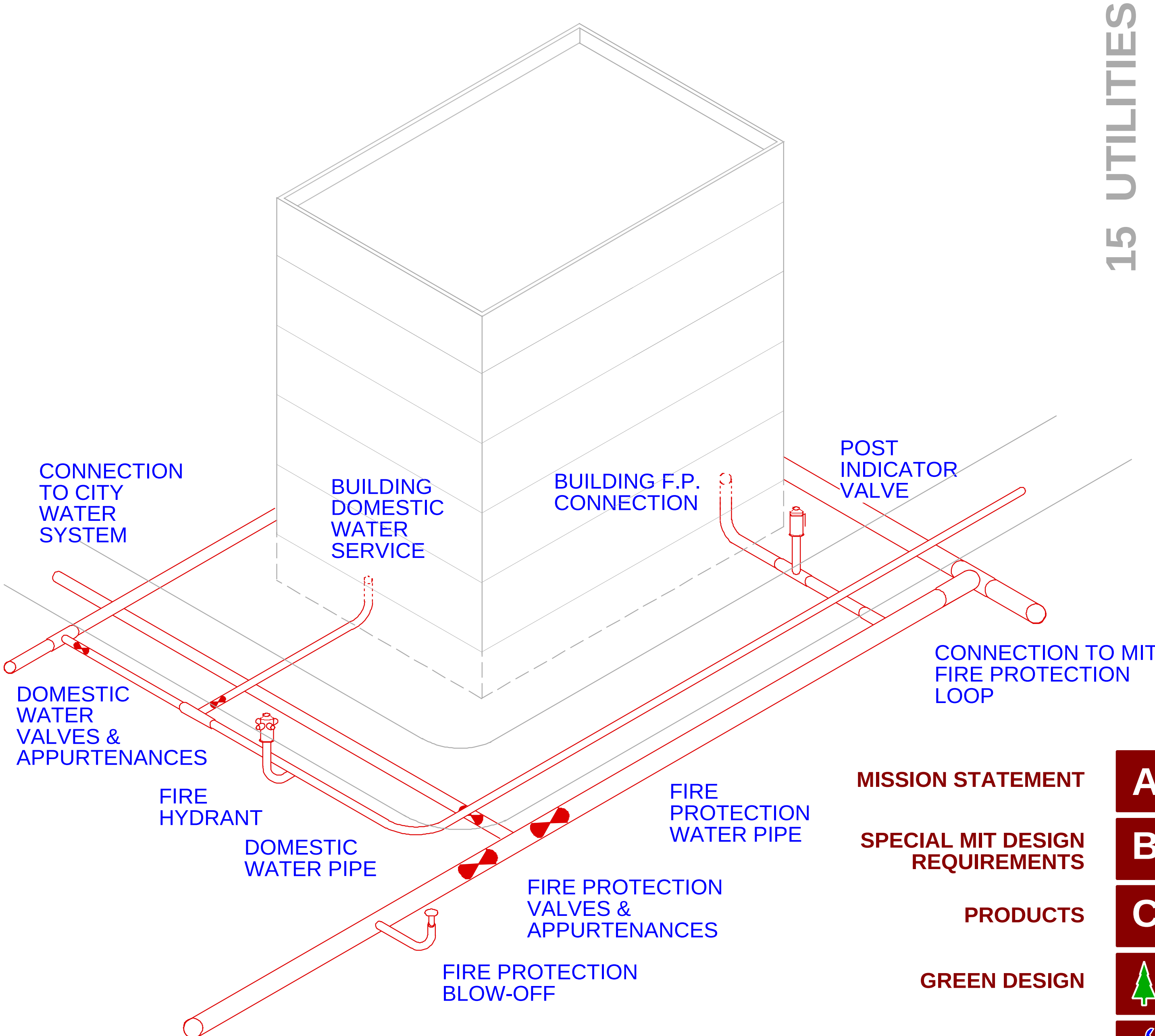


Click here for Required Engineering Documents



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(click here for Steam & Condensate)
(click here for Hot Water Piping)
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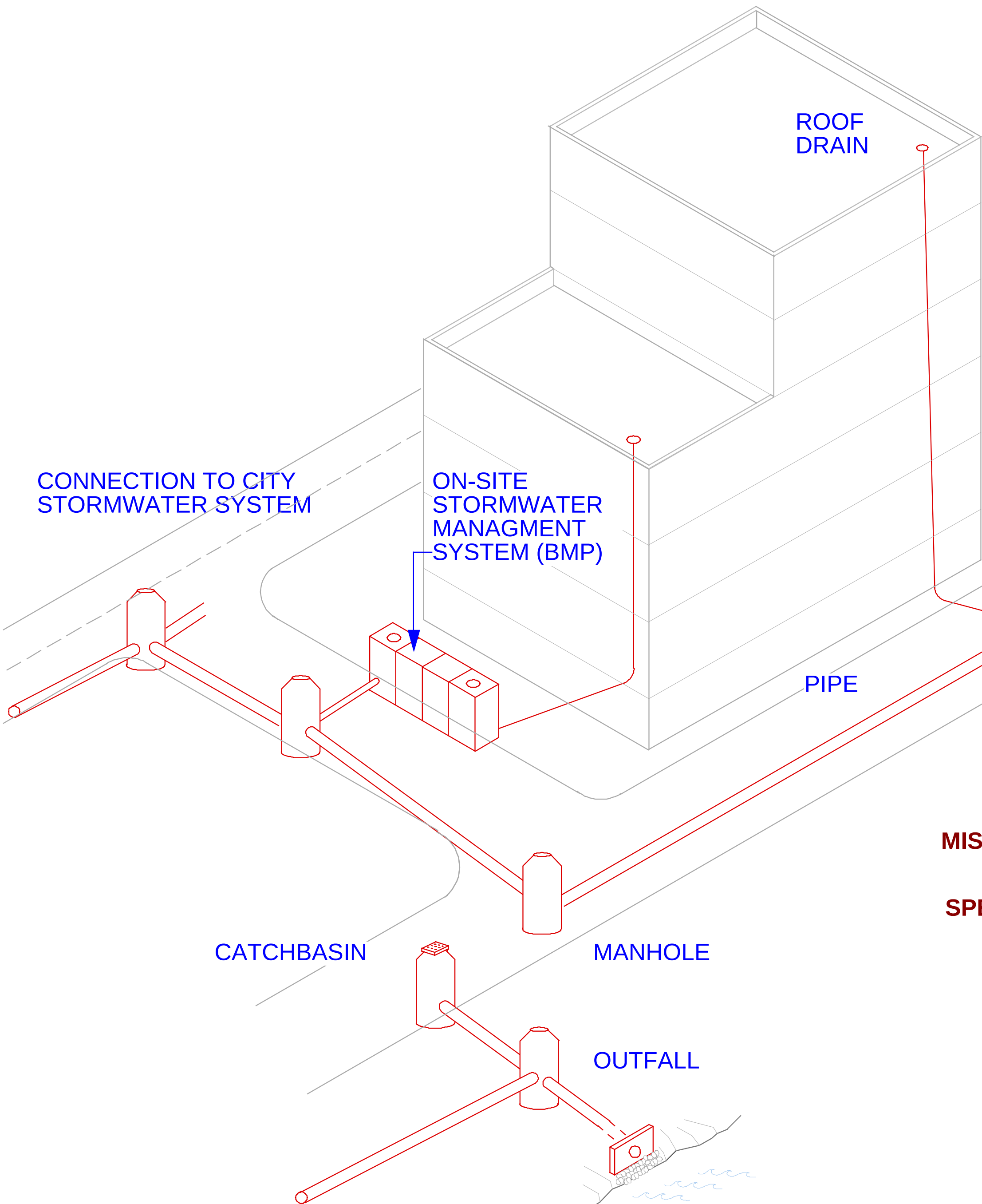

UTILITIES: STORMWATER

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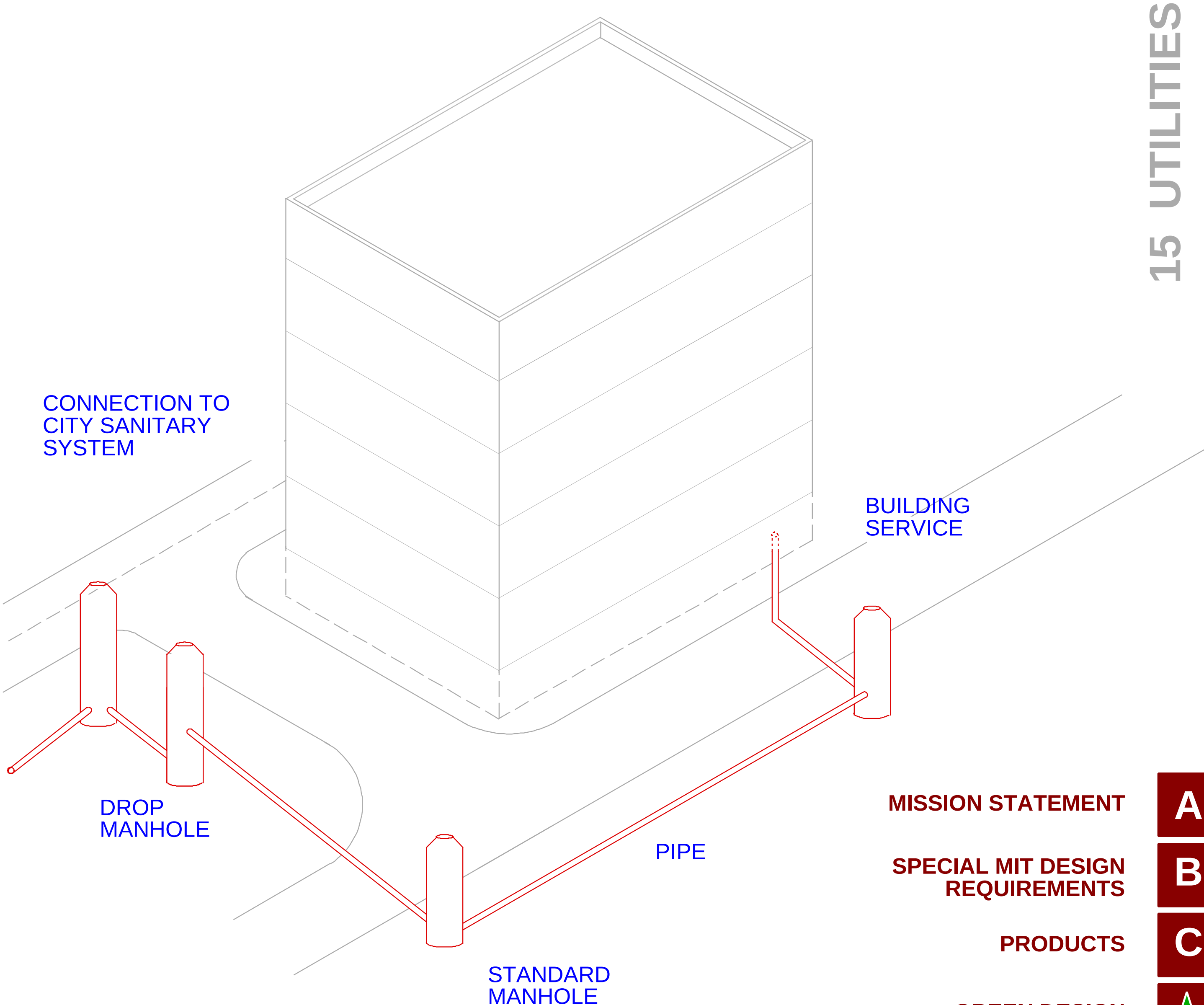

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UTILITIES: SANITARY SEWER

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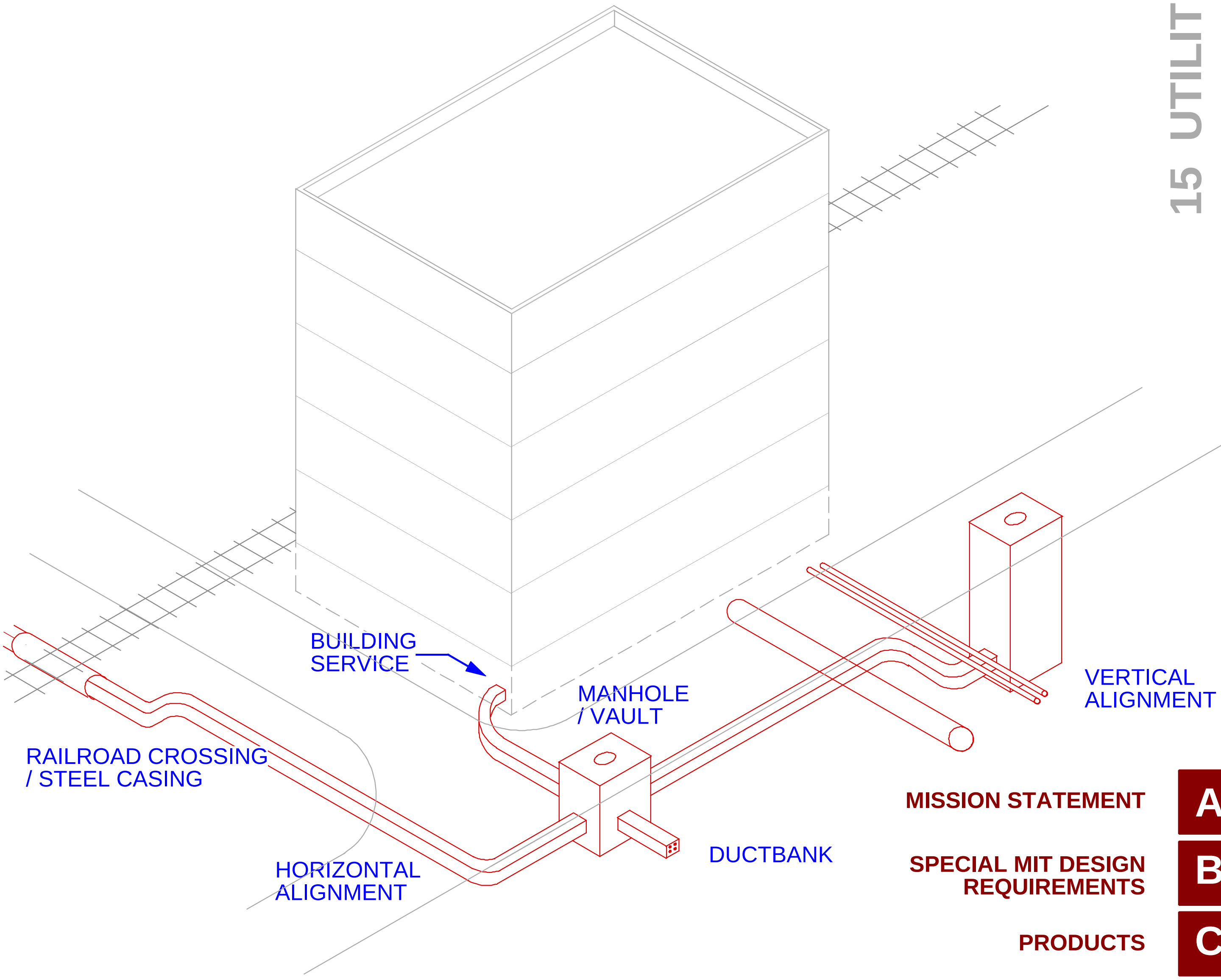
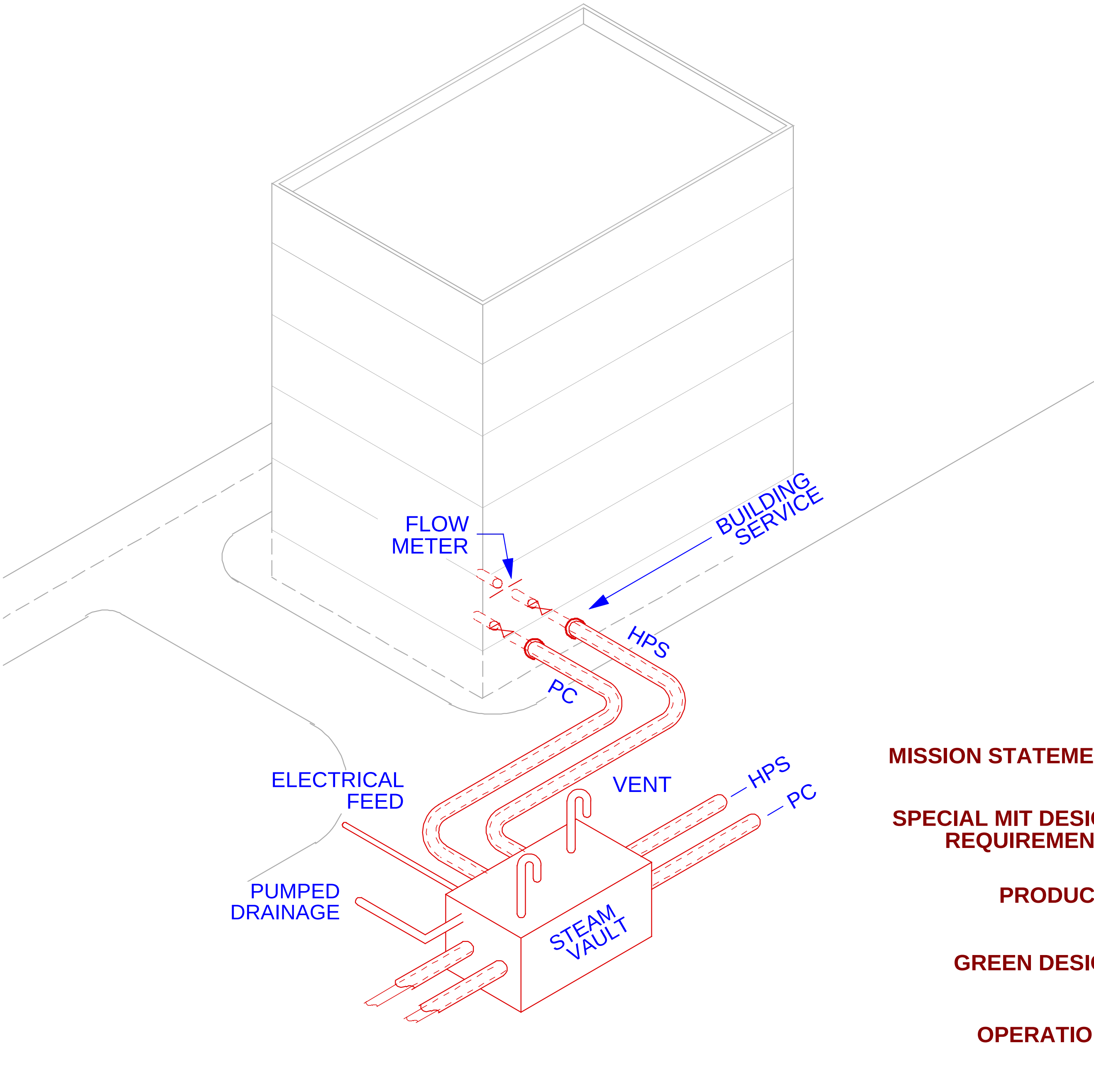
(click here for Stormwater)
(click here for Ductbanks)
(click here for Steam & Condensate)
(click here for Hot Water Piping)
(click here for Chilled Water Piping)



MISSION STATEMENT A
SPECIAL MIT DESIGN REQUIREMENTS B
PRODUCTS C
GREEN DESIGN
OPERATIONS
EHS
INSTITUTE SPACES ART, ARCHITECTURE & PRESERVATION
LABORATORY SERVICES
DESIGN REVIEW CHECKLIST

UTILITIES: DUCT BANKS

(click here for Domestic Water & Fire Protection)
(click here for Stormwater)
(click here for Sanitary Sewer)
(click here for Steam & Condensate)
(click here for Hot Water Piping)
(click here for Chilled Water Piping)



MISSION STATEMENT A
SPECIAL MIT DESIGN REQUIREMENTS B
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GREEN DESIGN
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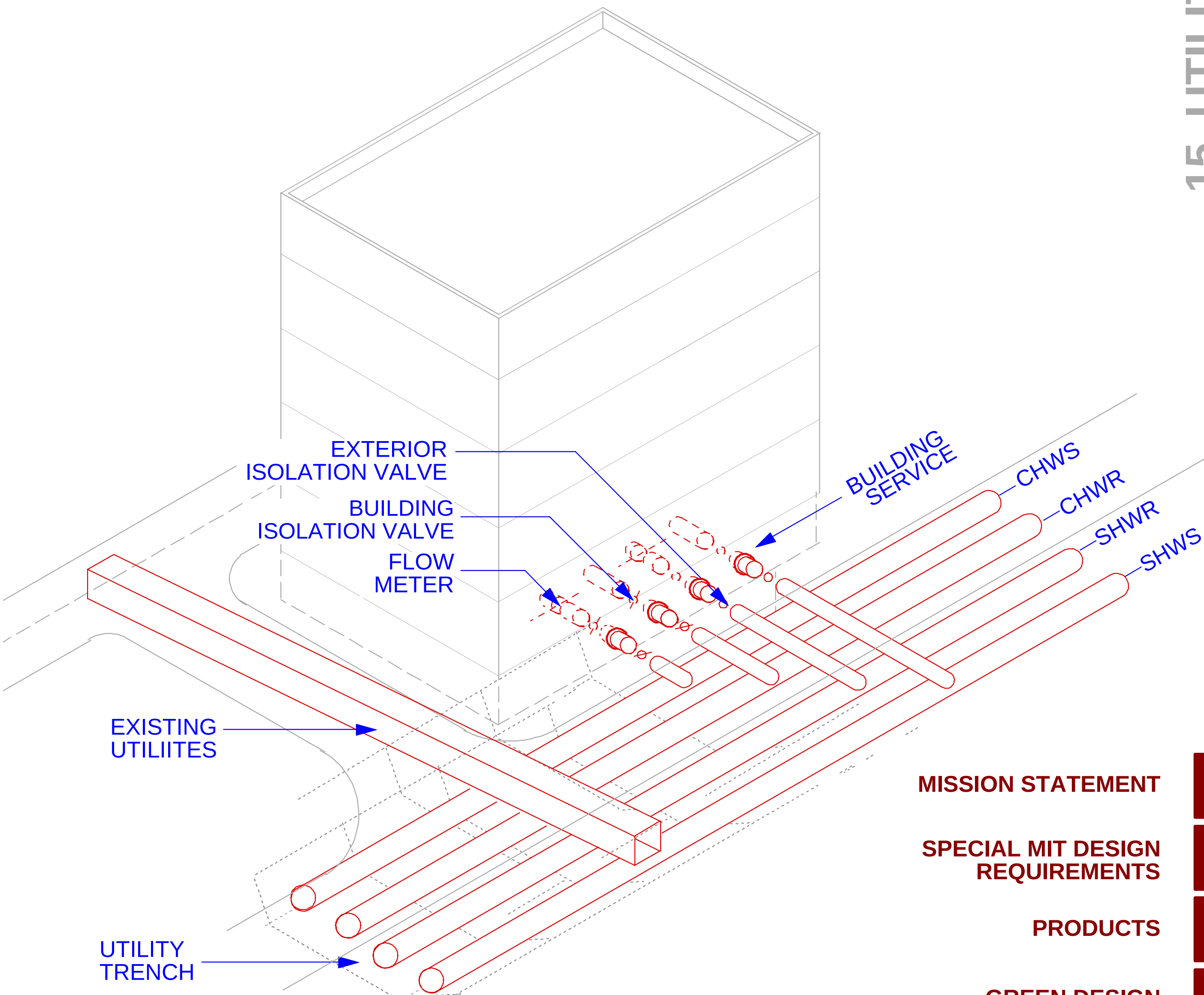
LABORATORY SERVICES
DESIGN REVIEW CHECKLIST

UTILITIES: STEAM, CONDENSATE

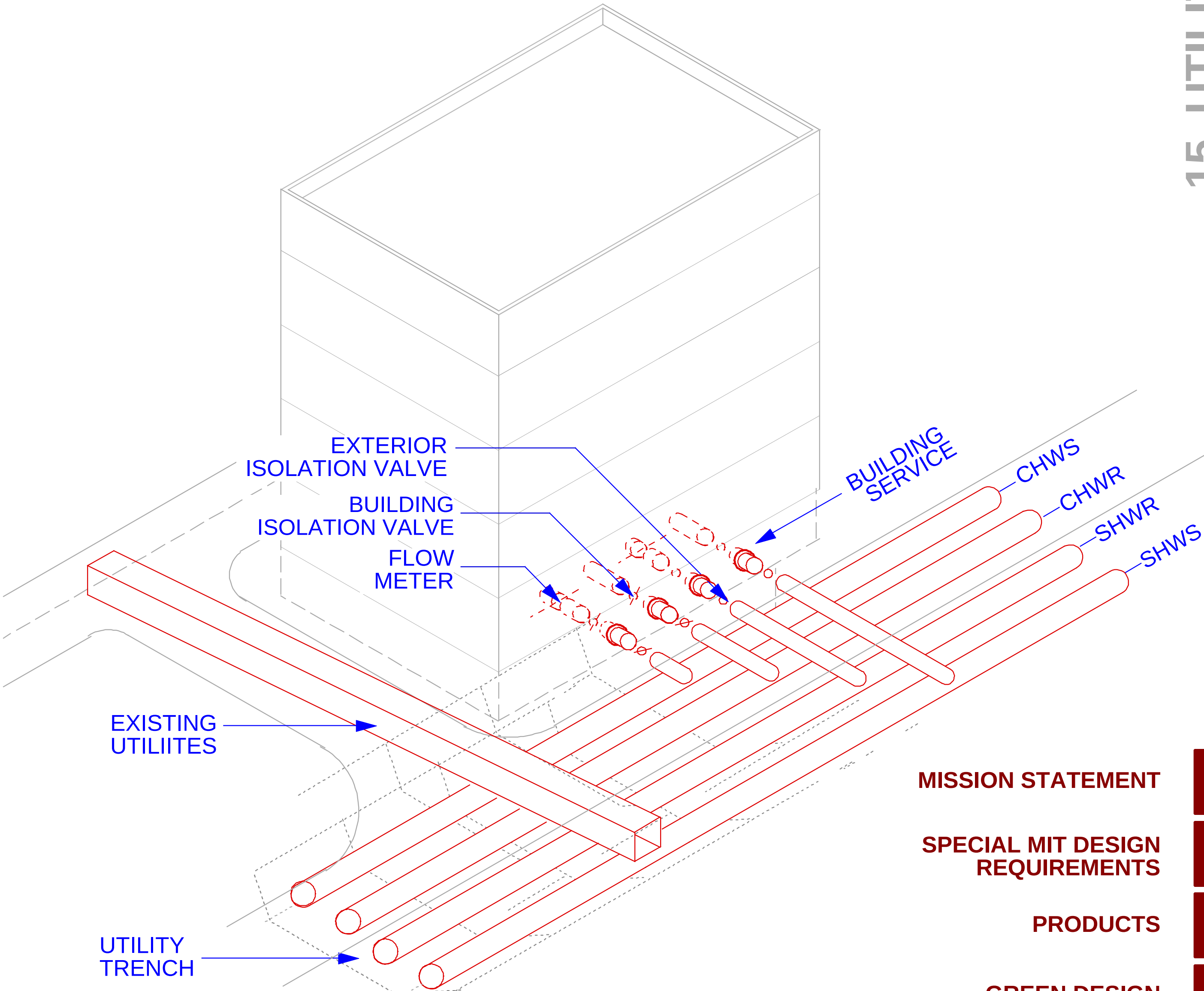
(click here for Domestic Water & Fire Protection)
(click here for Stormwater)
(click here for Sanitary Sewer)
(click here for Duct Banks)
(click here for Hot Water Piping)
(click here for Chilled Water Piping)

MIT Department of FACILITIES
BUILDING SYSTEMS
DESIGN HANDBOOK



UTILITIES: HOT WATER PIPING

(click here for Domestic Water & Fire Protection)
(click here for Stormwater)
(click here for Sanitary Sewer)
(click here for Duct Banks)
(click here for Steam & Condensate)
(click here for Chilled Water Piping)



MISSION STATEMENT A
SPECIAL MIT DESIGN REQUIREMENTS B
PRODUCTS C
GREEN DESIGN
OPERATIONS
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INSTITUTE SPACES ART, ARCHITECTURE & PRESERVATION
LABORATORY SERVICES
DESIGN REVIEW CHECKLIST

UTILITIES: CHILLED WATER PIPING

(click here for Domestic Water & Fire Protection)
(click here for Stormwater)
(click here for Sanitary Sewer)
(click here for Duct Banks)
(click here for Steam & Condensate)
(click here for Hot Water Piping)

MIT Department of FACILITIES
BUILDING SYSTEMS
DESIGN HANDBOOK

Mission Statement

The design of utility systems and the equipment specified for utilities should allow for maintenance with the priority on public safety.

The equipment life should exceed 40 years with consideration of longer life evaluated against initial capital cost where equipment has not been standardized.

Products are standardized for maintainability and overall system reliability. New products are considered for added longevity and future availability.

MIT promotes creative solutions to design challenges balanced by the constant emphasis on reducing requirements for maintenance of equipment while increasing energy savings

Top Ten Utilities Design Issues
(not prioritized)

Utilites (General)

1) Review and incorporation of field quality control, testing, cleaning, and initial chemical treatment for systems.

2) Identification and coordination of design with existing services and work of other disciplines and other site designers.

3) Selection and design supports, anchors, guides and thrust blocks.

4) Compliance with all local code issues. (Distance requirements between services)

5) Adequate venting and draining of piping systems and manholes for filling, draining, shutdown and maintenance.

6) Valves and instruments must be located for ease of operation, accessibility and readability.

7) Review options for expansion of piping system (i.e.,expansion loops, expansion joints, configured Z-bends); minimize expansion joints.

8) Provisions for operation of isolation valves and bypass valves from street level using reach rods.

9) Utilize test pit data and select test pit locations to identify potential interference locations with existing.

10) Excavated soil is likely to be considered contaminated under the Massachusetts Contingency Plan (MCP).

Domestic Water and Fire Protection

1) All domestic water pipes with less than 4 1/2 feet of cover must be insulated and be analyzed for potential traffic load impacts.

2) Fire Protection piping shall be buried with a minimum of 5 feet of cover.

3) Wherever possible, water mains shall be installed at least 10-feet horizontally from any existing or proposed sewer. If horizontal separation is not possible, the main should be installed in a separate trench or on an undisturbed earth shelf located on one side of the sewer. The invert of the water main should be at least 18-inches above the top of sewer

4) Restrained joints should be used in place of thrust blocks to prevent movement of water pipes.

5) All pipe and appurtenances used for fire protection systems must have Factory Mutual approval.

6) Domestic water and fire protection system designs require the approval of the Cambridge Water Department prior to construction. (See **Connection to City Water System**) Refer to Cambridge Water Department "Construction and Operating Practices" for minimum criteria for the construction of utilities within City limits.

Stormwater

1) Compliance with City of Cambridge stormwater policy and NPDES regulations.

2) Reference stormwater chapter of "MIT – A Framework for Campus Development"

Sanitary Sewer

1) The minimum design flow velocity is 2 ft/s in all gravity pipes.

2) Wherever possible, sewer pipe shall be installed at least 10-feet horizontally from any existing or proposed water main. If horizontal separation is not possible, the pipe should be installed in a separate trench or on an undisturbed earth shelf located on one side of the water main. The top of the sewer main should be at least 18-inches below the invert of the water.

3) Interior drop manholes should be installed for vertical drops greater than 2 feet.

4) Design safeguard against backflow for all basement services.

5) All sanitary system elements shall be designed in compliance with the current City of Cambridge Department of Public Works (DPW) standard specifications or other guidelines as directed by that agency.

Ductbanks

1) All ducts shall be 5" in diameter.

2) Ductbanks shall be buried a minimum of 30".

3) All ducts shall slope towards manholes and away from building penetrations. No isolated low points will be allowed.

4) An application for Grant of Location must be filed with the City of Cambridge Pole and Conduit Commission and approved prior to construction of any ductbank in the public way.

5) Wherever feasible, electrical and telecommunication ducts are to be constructed within a common ductbank.

Steam and Condensate

1) Steam main drip locations and detailing.

2) Vault / Tunnel / Trench design accounts for ease of installation, maintenance and repair.

3) Condensate handling – flash tanks, injection quills, pump sets and trapping have been accounted for and located.

4) Label and identify pitch of piping for proper condensate removal.

5) Provide proper clearances between steam and condensate piping and other piping and structures.

Hot Water

1) System design should minimize pipe stress where possible.

2) Provide adequate clearances to other piping systems and structures.

3) Arrange hot water supply and return piping so as to minimize heat transfer to chilled water piping.

4) Provide provisions for cleaning and flushing of piping in system design.

Chilled Water

1) Selection of proper corrosion protection systems and building sealants for site soil conditions. (conductivity, resistivity, acidity and water table)

2) Chilled water piping (ductile iron) joints to be mechanically restrained.

3) Where mechanically-restrained factory joints are not possible in design, megalug joints are required.

4) Maximize factory joints where possible; minimze megalug joints in system design.

5) Provide for temporary restraints during hydrostatic testing.

Utilities — General

Cathodic Protection System

Provide complete isolation kits for pipe flanges to provide cathodic isolation.

Service Standards: Provide isolation kits appropriate for M.I.T. pressure standards:

1.	Steam Distribution Mains	300 lb.
2.	Condensate	150 lb.
3.	Chilled Water	150 lb.
4.	Condenser Water	150 lb.

Isolation Kit Materials: Specify as follows; substitutions are not acceptable. One complete kit consists of the following:

	Item	Quantity	Material
5.	Bolt sleeves	1 per bolt	Silicone rubber, fiberglass composite
6.	Washers Type 1	2 per bolt	Klingerite
7.	Washers Type 2	2 per bolt	Cadmium plated steel
8.	Gaskets	1 per flange	Klingerite

Acceptable Manufacturer: Intergy/Ricwill Piping Systems, P.O. Box 939, Boston, MA 02117.

Cathodic Corrosion Protection System for Underground Piping and Pipe Casings.

Provide sacrificial anode type cathodic corrosion protection systems for all direct burial steel pipes with steel outer casings including, without limitation, chilled water lines, steel conduit for steam and condensate lines, and condenser water lines.

A. Designer Qualifications: The designer of the cathodic corrosion protection system must be a recognized firm specializing in this work and must assume responsibility for the performance and adequacy of the system. Shop drawings shall be submitted, stamped by a professional engineer in responsible charge of the system design.

B. Complete System Required: Provide a complete system including, without limitation, anodes, wiring, test stations, installation instructions, and all other components and accessories needed for a fully functional system.

C. System Design Parameters: Base design on 7 percent of pipe surface considered bare and not less than 2 milliAmps of current per square foot of bare surface. Use magnesium anodes and design for 20-year life span.

D. Test Stations: Provide test stations along the pipe not over 500 feet apart. Terminate test leads at ground surface in cast iron housings encased in concrete or, if structures are nearby, house test leads in electrical conduit and terminate in waterproof junction boxes attached to the structure. Provide at least 18” of slack lead in the terminating box.

E. Below Grade Conditions: Prior to system installation, make an earth resistivity survey along the line of buried piping, taking at least five soil samples from representative locations. For each sample, determine the chemical analysis, electrical resistivity, pH, percentage of water-soluble salts, chloride content, and sulfate content. Employ specialists for this testing and provide detailed written reports with conclusions.

F. Electrical Isolation: Electrically isolate cathodic protected piping from other buried structures and from connected building piping systems with Cathodic Protection System – Isolation Kits as described in this Guideline.

G. Connections to Piping: Make underground wiring connections by the cadwelding process.

H. Preconstruction Submittals: Provide complete schematic drawings of the entire proposed system and obtain approval from M.I.T. Project Manager prior to continuing work. Accurately show the layout of the system, the number of anodes, the location and number of test stations, details of test stations and wiring, installation details including details for cadwelding of wires to pipes.

I. Record Drawing Submittal: Before final acceptance and as a prerequisite to final payment, provide complete, accurate, dimensioned Record “as built” Drawings of the entire system showing the precise location of all anodes, test stations, and routes of connecting cables. Obtain approval of Record Drawings from M.I.T. Project Manager.

J. Backfilling: Test, check, and protect connections and wiring before backfilling. Backfill in a manner to prevent damage to system. **(See Trench Detail C-1)**

K. Testing and Reporting: Provide complete and thorough testing of the installed system and provide additional anodes and alterations as needed to ensure proper performance. Provide detailed written test reports showing measured Performance Data for the system in sufficient detail to serve as basis for future system condition evaluation.

L. Designer Certification: The Designer of the system shall provide on-site observation during installation of the anodes and test stations, shall report in writing any work not done in conformance with the Design Documents. Upon completion of the system installation, the Designer shall provide a certified letter stating that the installation has been made properly, is in conformance with the Design Documents, and is performing to provide adequate piping protection.

M. Warranty: Provide a comprehensive written warranty extending from one year from Date of System Acceptance by M.I.T., to guarantee the proper function of the entire system. Warranty shall provide all labor, materials, and costs for complete replacement of all failed and improperly performing work and components with new work and components, and shall provide for uncovering and recovering defective work and components.

Clearances and Coordination

Coordinate the Construction Documents to ensure that piping does not conflict with ducts, structure, lighting, architectural finishes, and other work. Verify ceiling heights and pipe locations including low points of pitched piping.

Require the Contractor to notify the Engineer/Architect and M.I.T. Project Manager immediately upon discovery of any conflict and whenever height clearance is less than 7'-0" above finished floors.

Pipe Materials and Installation Guidelines

1. For basic general information on piping, pipe fittings and valves refer to the **Pipe Index**:

2. Comply with the following installation requirements:

A. Equipment Connection: To accommodate thermal expansion or settlement, provide three elbow swing joints at piping run-outs to equipment. Support piping independently and not on equipment.

B. Drains: Provide drain valves and 3/4" hose connections at low points of each hydronic line to permit complete draining of entire system.

C. Vents: Provide vent valves at high points of each hydronic piping system to permit complete purging of air from the system. Automatic vents require isolation valves. See standard M.I.T. details.

D. Shut-of Valves: Provide shut-off valves for each branch in the system.

E. Temporary Caps: Cap or plug open ends of lines and equipment to keep dirt and foreign matter out.

F. Temporary Work: Provide temporary cross-connections, valves, oversize flushing connections, pumps, and other work and components as needed to thoroughly flush systems.

G. Pipe Expansion: Control expansion through bends, expansion joints, and offsets. Design work so that mains, branches and runouts can expand and contract freely without developing leaks or over-stressing. Limit stresses to allowable limits specified in ANSI B31.1.0, Code for Pressure Piping.

H. Pipe Cutting and Fitting: Cut and fit pipe cleanly and accurately. Do not permit springing or forcing of pipe into place. Ream pipe to remove burrs.

I. Pipe Locations: Locate piping to clear windows, doors, and other openings and passages.

J. Cutting for Piping: Do not cut or weaken structures to facilitate piping installation, unless approved by the M.I.T. Project Manager.

K. Changes in Direction and Size: Provide fittings for all changes in direction and reducing fittings for all changes in size. In steel piping systems, where size of fitting is not available as standard, cut-in type welding fittings [such as Bonney "Weldolets" for 2-1/2" and larger, and Bonney "Sockolets" for 2" and smaller] may be used. Bonney "Thredolets" may be used for direct attachment of screwed devices only. Provide accurately made and carefully matched intersections for openings cut into pipe.

L. Refer to the following typical details for the Pipe Installation Guidelines:

M-5 Pipe Hanger Support

M-7 Multiple Pipe Support

C-1 Pipe Bedding & Backfill

Strainers

Provide strainers to protect equipment against damage caused by dirt, scale, rust jointing material, weld metal and other foreign particles that are common in pipes and pipelines. Provide strainers based on pipe class (See **Strainer Table**)

Pipe Welding Guidelines

Conform to ANSI B31.1.0 and applicable portions of ASME Boiler and Pressure Vessel Code. Submit, for M.I.T. Project Manager approval and record, certified copies of Procedure Specification for Welding, Welding Procedure Qualification Tests, and Welder Performance Qualification Tests. Record welding specifications and qualification tests on Forms Q-1 as recommended in Appendix II of Section IX of the ASME Boiler and Pressure Vessel Code. The Contractor shall certify all records.

A. Welding Requirements: Bevel piping on both sides of joint before welding and larger. Before welding, remove all corrosion and foreign material from surfaces to be welded. Use DC current exclusively and weld by either manual shield metallic arc process or automatic submerged arc process. Comply with ASTM A233, Classification E-6010 for electrodes, voltages, currents, thickness, and number of passes and beads to be used with manual shielded metallic arc welding method.

B. Weld Spacing: Use the following weld spacing on all pipe butt welds:

Nominal Pipe Wall Thickness	Spacing
1/4” or less	1/8”
Over 1/4” and less than 3/4”	3/16”
3/4” and over	3/16”

Quality Control, Piping Cleaning and Testing Reports

A. Refer to the following report sheets to be used in installation specifications for Quality Control, Piping Cleaning and Testing:

Quality Control Report: **QC-1 Steam and Condensate Piping**

Quality Control Report – Holds: **QC-2 Steam and Condensate Piping**

Quality Control Report: **QC-3 Hot Water Piping**

Quality Control Report - Holds: **QC-4 Hot Water Underground Piping**

Quality Control Report –Leak Detection Wires: **QC-5 Hot Water Underground Piping**

Piping Cleaning Report QC-6

Piping Test Report QC-7

QUALITY CONTROL REPORT

MIT Utilities

INSPECTION REPORT NO. _________

Activity: STEAM AND CONSENSATE PIPING

Specification Section: 15600

Location:

G.C. / Subcontractor:

Date:

QA/QC Representative:

Existing Condition:

Requirements			***Description***	***Comments***
Approved Submittal	Yes	No		
Material Delivery Inspections	Yes	No		
Manufacturer's Certifications	Yes	No		
Excavation & Backfill Checklists	Yes	No		
Cold Springing	Yes	No		
Welding Checklist	Yes	No		
Welding Xrays	Yes	No		
Drain / Vents Installed	Yes	No		
Pipe Identification Tape Installed	Yes	No		
Hydrostatic Test (150% Oper Press)	Yes	No		

Deficiencies Noted:

Corrective Action Taken:

Remarks:

Contractor's Acknowledgement: The above report is, to the best of my knowledge, complete, correct and all material and equipment used and work performed at this observation are in compliance with the contract documents except as noted.

Signature:

(back to text)

QUALITY CONTROL REPORT- HOLDS

MIT Utilities

INSPECTION REPORT NO. _________

Activity: STEAM AND CONDENSATE PIPING

Specification Section: 15600

Location:

G.C. / Subcontractor:

Date:

QA/QC Representative:

Existing Condition:

Requirements			***Description***	***Comments***	***Sign off***	
					Engineer	MIT inspector
Inspection of weld map check list	Yes	No	Produce map weekly	**Hold**-Casing weld close-ups	NA	
Review of NDT test results	Yes	No	Produce with Weld map	**Hold**-Casing weld close-ups		
Inspection of casing for debris	Yes	No	On site inspection by MIT	**Hold**-Casing weld close-ups	NA	
Casing weld visual inspection	Yes	No	Daily reports due	**Hold**-Joint seal closure	NA	
Pipe support inspection	Yes	No	One week notice	**Hold**-Hydo test		
Hydro test carrier pipe	Yes	No	One week notice	**Hold**-MIT inspector	NA	
Air test casing pipe	Yes	No	One week notice	**Hold**-MIT inspector	NA	
Vault piping inspection	Yes	No	One week notice	**Hold**-Pipe Insulation		
Inspection of trench area	Yes	No	Pictures required w/report	**Hold**-Back fill	NA	
Survey of installed piping	Yes	No	Red line drawing required	**Hold**-Back fill		
Inspection of insulation	Yes	No			NA	

Deficiencies Noted:

Corrective Action Taken:

Remarks:

Contractor's Acknowledgement: The above report is, to the best of my knowledge, complete, correct and all material and equipment used and work performed at this observation are in compliance with the contract documents except as noted.

Signature:

(back to text)

QUALITY CONTROL REPORT

MIT Utilities

INSPECTION REPORT NO. _________

Activity: HOT WATER PIPING

Specification Section: 15600

Location:

G.C. / Subcontractor:

Date:

QA/QC Representative:

Existing Condition:

Requirements			***Description***	***Comments***
Approved Submittal	Yes	No		
Material Delivery Inspections	Yes	No		
Manufacturer's Certifications	Yes	No		
Excavation & Backfill Checklists	Yes	No		
Welding Checklist	Yes	No		
Welding Xrays	Yes	No		
Drain / Vents Installed	Yes	No		
Pipe Identification Tape Installed	Yes	No		
Hydrostatic Test (150% Oper Press)	Yes	No		
Resident Engr. On Site	Yes	No		

Deficiencies Noted:

Corrective Action Taken:

Remarks:

Contractor's Acknowledgement: The above report is, to the best of my knowledge, complete, correct and all material and equipment used and work performed at this observation are in compliance with the contract documents except as noted.

Signature:

(back to text)

QUALITY CONTROL REPORT- HOLDS

MIT Utilities

INSPECTION REPORT NO. _________

Activity: HOT WATER UNDERGROUND PIPING

Specification Section: 15600

Location:

G.C. / Subcontractor:

Date:

QA/QC Representative:

Existing Condition:

Requirements	Status Complete		Description	Comments	Sign off	
					Engineer	MIT inspector
Pipe Bedding inspection	Yes	No	One week notice	**Hold**-Installation of piping	NA	
Inspection of Leak detection wires	Yes	No	Produce sketch & photos	**Hold**-Joint closure	NA	
Meter reading of installed wires	Yes	No	Produce readings and map	**Hold**-Joint closure		
Inspection of weld map check list	Yes	No	Produce map weekly	**Hold**-Joint closure	NA	
Review of NDT test results	Yes	No	Produce with Weld map	**Hold**-Joint closure		
Hydro test carrier pipe	Yes	No	One week notice	**Hold**-Joint closure	NA	
Joint insulation inspection	Yes	No	One week notice	**Hold**-Joint seal closure	NA	
Joint seal inspection	Yes	No	One week notice	**Hold**-Back fill	NA	
Wall penetration inspection	Yes	No	Inspection for proper clearance	**Hold**-Pipe welding		
Inspection of trench area	Yes	No	Pictures required w/report	**Hold**-Back fill	NA	
Survey of installed piping	Yes	No	Red line drawing required	**Hold**-Back fill		

Deficiencies Noted:

Corrective Action Taken:

Remarks:

Contractor's Acknowledgement: The above report is, to the best of my knowledge, complete, correct and all material and equipment used and work performed at this observation are in compliance with the contract documents except as noted.

Signature:

(back to text)

QUALITY CONTROL REPORT- LEAK DETECTION WIRES

MIT Utilities

INSPECTION REPORT NO. _________

Activity: HOT WATER UNDERGROUND PIPING

Specification Section: 15600

Location:

G.C. / Subcontractor:

Date:

QA/QC Representative:

Existing Condition:

Note coordinate location,Weld map number identifier, north symbol, pipe and wire connections

Leak detection wire diagram - required for each joint

Deficiencies Noted:

Corrective Action Taken:

Remarks:

Contractor's Acknowledgement: The above report is, to the best of my knowledge, complete, correct and all material and equipment used and work performed at this observation are in compliance with the contract documents except as noted.

Signature: ____________________

(back to text)

PIPING CLEANING REPORT

Area

System Cleaned ______________ Duration

Method: Chemical_________; Blowdown

Flush __________; Other

Location of Temporary Strainers/Filters, Etc.

Detergent Wash? Yes ___; No___; Concentration

Duration

Exceptions Made to Specifications

Approved By ________________ Date

Section Cleaned	Date	Foreman	Engineer
From: _________	_________	_________	__________
To: __________		_________	__________
From: _________	_________	_________	__________
To: __________		_________	__________
From: _________	_________	_________	__________
To: __________		_________	__________
From: _________	_________	_________	__________
To: __________		_________	__________

Utility Piping

PIPING TEST REPORT

Project Number __________; Project Title ___________________________;

System Tested ____;

Pressure, Beginning ___ Psig; End ___ Psig; Time Interval

How Tested: Hydrostatic ____ Pneumatic ____ Vacuum__________;

Exceptions Made to Specifications:

Reasons for Exceptions:

Approved By: __________________ Date:

	Section Tested:	Date	Foreman	Owner
From:				
To:				

List all auxiliary equipment used in each test (pumps, gauges, etc.) including serial numbers and calibration dates.

Chest list after pressure test:

Required	Done	Not
System Drained	______	_______
System Air Dried	______	______

Required	Done	Not
Temporary Equipment (Gauges, Caps, Etc.) Replaced	________	______
Safety and Relief Valves Replaced	________	______
Valving Returned to Proper Configuration	_______	______

Remarks:

Domestic Water

Domestic Water Pipe

1) For basic general information on piping, and fittings, refer to **Pipe Index**.

2) Distribution system pipe shall be a minimum of 8" in diameter and pipe used for hydrant branches shall be a minimum of 6" in diameter. Mains shall be sized so that the velocity is in range of 2.5 to 5 feet per second.

3) Assume minimum trench width of pipe diameter plus 2-feet, with a minimum of 3 feet, for water main installation (See **Typical Pipe Trench Detail C-1**).

4) All water pipes with less than 4 1/2 feet of cover must be insulated and be analyzed for potential traffic load impacts. Insulation shall be FOAMGLAS insulation with flexible PITTWRAP jacketing as manufactured by Pittsburgh Corning, or approved equal.

5) Sand borrow or crushed stone shall be used as pipe bedding placed from 6 inches below pipe invert to 6 inches above pipe crown.

6) Dead ends should be minimized or eliminated by the looping of all water mains whenever practical. When dead ends occur, a hydrant or **blow off valve** should be installed for flushing purposes.

7) **Fittings** (90°, 45°, 22 1/2 °, and 11 1/4°) shall be used to direct pipe from the normal alignment.

8) **Hydrants** are to be placed at approximately 500 foot intervals. Normal placement is between properties, along the property line if possible. Fire Hydrant model and locations shall be approved by the Cambridge Fire Department (CFD) and the Cambridge Water Department (CWD).

9) **Restrained joints** shall be furnished for installation on all fittings, hydrants, sleeves, and valves.

10) Restrained joints shall be installed in the vicinity of all bends, 40 feet in each direction from 90 degree bends and 30 feet in each direction from 45 degree bends.

11) Utility warning tape shall be installed to provide warning and identification of buried piping. Tape shall specify "Cambridge Water" or "MIT Water" depending on ownership.

12) All pipe and appurtenances installed shall be hydrostatically tested in accordance with ANSI/ AWWA C600, latest version. Leakage testing shall be conducted in conjunction with pressure tests.

13) Disinfection shall occur after successful pressure and leakage testing. Perform disinfection and flushing in accordance with AWWA C651. If connections are made to municipal water systems, Owner-approved backflow preventers shall be installed in the line to prevent backflow or siphonage of water into the municipal system.

14) Where water piping pass under a railroad track, the pipe shall be installed in a steel casing. Work within the railroad right-of way shall be subject to the control and requirements of CSX Transportation, Inc. as described in the "Specific Requirements of Consolidated Rail Corporation for Work on its Right-of Way (CE-6, Rev. 2-97)".

Domestic Water Valves and Appurtenances

1) For basic general information on valves and appurtenances refer to **Pipe Index**.

2) Line valves shall be spaced at not more than 500 feet and as determined by the CWD. Mains less than 16" diameter shall be furnished with **gate valves**. Mains 16" and larger shall be furnished with **butterfly valves**.

3) **Valve box** covers shall have the word "WATER" cast on the top. A minimum 6-inch overlap is required between sliding sections. The inside diameter of boxes shall be at least 5 1/4 inches and lengths shall be as necessary to suit ground elevation.

4) Buried valves shall be set with the operating stem vertically aligned in the center of the valve box. Valves shall be set on a firm foundation.

Building Domestic Water Service (See **Detail C-7**)

1) Water services to properties shall consist of a **corporation** into the main**,** **copper service tubing**, and a **curb stop** at the property line.

2) Services shall be sized based on the expected demands of the building being serviced.

Connection to City Water System

1) A Permit Application for Water Works Construction can be obtained from the City of Cambridge, Water Department, 250 Fresh Pond Parkway, Cambridge, Massachusetts 02138.

2) Connections to existing mains shall be accomplished using a **Tapping Sleeve** and Valve to avoid having the water main shut down.

3) Where there is more than one public water main in a street, the CWD shall determine which main may be tapped for a water service pipe connection.

4) All new taps shall be a minimum of one pipe size smaller than the main to be tapped. Otherwise, a solid sleeve three-way branch shall be used to connect to the new main.

Fire Protection

Fire Protection Water Pipe

1) For basic general information on piping, fittings, and valves, refer to **Pipe Index**.

2) Assume minimum trench width of pipe diameter plus 2-feet with a minimum of 3 feet, for water main installation. (See **Typical Pipe Trench Detail C - 1**)

3) Fire protection piping must be buried with a minimum of 5 feet of cover.

4) Sand borrow or crushed stone shall be used as pipe bedding placed from 6 inches below pipe invert to 6 inches above pipe crown.

5) Dead ends should be minimized or eliminated by the looping of all water mains whenever practical. When dead ends occur, a **blow off valve** should be installed for flushing purposes. (Note: Blow off valves and hydrants must be protected from operating pressures in excess of 150 psi by a normally closed gate valve.)

6) Restrained joints shall be furnished for installation on all joints, fittings, hydrants, sleeves, and valves.

7) Utility warning tape shall be installed to provide warning and identification of buried piping. Tape shall indicate ownership, "MIT Fire Protection".

8) Upon completion of work, a "**Contractor's Material & Test Certificate for Underground Piping**" shall be completed as required by Factory Mutual.

Fire Protection Valves and Appurtenances

1) Valve box covers shall have the word "FIRE" cast on the top. A minimum 6-inch overlap is required between sliding sections. The inside diameter of boxes shall be at least 5 1/4 inches and lengths shall be as necessary to suit ground elevation.

2) Buried valves shall be set with the operating stem vertically aligned in the center of the valve box. Valves shall be set on a firm foundation.

3) Gate valves and post indicator valves shall have a rated operating pressure which is greater than the system design operating pressure.

4) Building mounted indicator valves are not allowed. All fire protection appurtenances must be reviewed and approved by MIT Facilities.

5) Hydrants shall not be used.

Building Fire Protection Connection

1) **Gate valves** and **post indicator valves** shall have a rated operating pressure which is greater than the system design operating pressure.

2) Building mounted indicator valves are not allowed. All fire protection appurtenances must be reviewed and approved by MIT Facilities.

3) Location and configuration of all fire post indicator valves and connections are to be reviewed and approved by MIT Facilities Department.

Connection to MIT Fire Protection Loop

1) MIT owns and operates an independent campus wide fire protection loop. The designer should obtain all required system operating information and system mapping from MIT Facilities in order to design building connections.

Contractor's Material & Test Certificate for Underground Piping

FM Global

Additional copies of this form are available to insureds form:
Customer Services, Factory Mutual, 1151 Boston Providence Turnpike, P.O. Box 9102, Norwood, MA 02062

Procedure: Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners and contractor. It is understood the owner's representatives signature in no way prejudices any claim against the contractor for faulty material, poor workmanship or failure to comply with approving authority's requirements or local ordinances.

Property I.D.

Property Name:	Date:
Property Location:	

Plans:

Accepted By Approving Authority's Name(s)
Address:
Installation Conforms to Plans ☐ Yes ☐ No Equipment Used is Approved (If no, state deviations): ☐ Yes ☐ No

Instructions:

Has person in charge of fire equipment been instructed as to the location of control valves and the care and maintenance of this new equipment? ☐ Yes ☐ No If no, explain:
Have copies of appropriate instructions and care and maintenance charts been left on premises? ☐ Yes ☐ No If no, explain:

Location:

Supplies Buildings:

Underground Pipes and Joints

Pipe Types & Class:	Type of Joint:
Pipe Conforms to	Standard. ☐ Yes ☐ No
Fittings Conform to If No, Explain:	Standard. ☐ Yes ☐ No
Joints needing anchorage clamped, strapped, or blocked in accordance with ☐ Yes ☐ No If no, explain:	standard.

Test Description:
Flushing: Flow the required rate until water is clear as indicated by no collection of foreign material in burlap bags at outlets such as hydrants and blow-offs. Flush at flows not less than 390 GPM (1476 L/min) for 4 inch pipe, 880 GPM (3331 L/min) for 6 inch pipe, 1560 GPM (5905 L/min) for 8 inch pipe, 2440 GPM (9235 L/min) for 12 inch pipe. When supply cannot produce stipulated flow rates, obtain maximum available.

Hydrostatic: Hydrostatic tests shall be made at not less than 200 psi (13.8 bars) for two hours or 50 psi (3.4 bars) above static pressure In excess of 150 psi (10.3 bars) for two hours.

Leakage: New pipe laid with rubber gasketed joints shall, if the workmanship is satisfactory, have little or no leakage at the joints. The amount of leakage at the joints shall not exceed 2 qts. Per hr. (1.89 L/h) per 100 joints irrespective of pipe diameter. The leakage shall be distributed over all the joints if such leakage occurs at a few joints, the installation shall be considered unsatisfactory and necessary repairs made. The amount of allowable leakage specified above may be increased by 1 fl. Oz. Per inch valve diameter per hour (30 mL/25mm/h) for each metal seated valve isolating the test section. If dry barrel hydrants are tested with the main valve open, so the hydrants are under pressure, an additional 5 Oz. Per Min. (150 mL/min) leakage is permitted for each hydrant.

Continued

Contractor's Material & Test Certificate for Underground Piping

Flushing Tests:

New Underground Piping flushed according to	standard.	☐ Yes	☐ No
By:	company.		
If no, explain: .			
How was flushing obtained?	☐ Public Water	☐ Tank or Reservoir	☐ Fire Pump
Through what type of opening?	☐ Hydrant Butt.	☐ Open Pipe	
Lead-ins flushed according to	standard.	☐ Yes	☐ No
By:	company.		
If no, explain: .			
How was flushing obtained?	☐ Public Water	☐ Tank or Reservoir	☐ Fire Pump
Through what type of opening?	☐ Open Pipe	☐ Y Conn. To Flange or Spigot	

Hydrostatic Testing:

Equipment operates properly? ☐ Yes ☐ No	If no, reason:
Drain Test Reading of gage located near water supply test pipe:	
Residual pressure with valve in test pipe wide open? psi.	
All new underground piping hydrostatically tested at psi for hrs.	Joints Covered? ☐ Yes ☐ No

Leakage Test:

Total amount of leakage measured: Gals.	Hrs.
Allowable leakage: Gals.	Hrs.

Hydrants:

Number Installed:	Type and Make:
All operate satisfactorily? ☐ Yes ☐ No	

Control Valves:

Water Control Valves Left Wide Open? ☐ Yes ☐ No **If no, state reason:** .
Hose threads of Fire Department connections and hydrants interchangeable with those of Fire Department answering alarm? ☐ Yes ☐ No

Remarks:

Signatures:

Name of Installing Contractor:

For Property Owner (Signed): Title: Date:

For Installing Contractor (Signed): Title Date:

Additional Explanation and Notes:

(back to text)

Stormwater

Pipes located on MIT property:

1) For basic information on piping, refer to **Pipe Index**.
2) Pipes with diameters smaller than 12” shall be Polyvinyl Chloride (PVC) SDR 35 or heavier as required.
3) Pipes with diameters 12” and larger shall be reinforced concrete pipe (RCP). Generally, class III concrete pipe is adequate when the pipe has at least 2.5 feet of earth cover. Where 2.5 feet of earth cover is not achievable, Class IV or heavier may be required. The design engineer shall be responsible for determining and specifying the pipe class.
4) Pipe sizes shall be calculated based on achieving self-cleaning velocities during the design storm.
5) Inverted siphons should not be designed in stormwater systems because of maintenance issues.

Pipes located on Public Property:

1) For basic information on piping, refer to **Pipe Index**.
2) New storm drain trunk mains shall be minimum of 15” diameter.
3) Catchbasin laterals shall be minimum of 10” diameter.
4) Building service pipes shall be minimum of 6” diameter.
5) Pipe sizes shall be calculated based on achieving self-cleaning velocities during the design storm.
6) Catchbasins shall connect directly to manholes.
7) All stormwater elements within public property shall be designed in accordance with the current City of Cambridge Department of Public Works (DPW) Standard Specifications. At the time of this writing, the DPW is working on new stormwater regulations. The DPW Engineering Department should be contacted to determine if the new regulations have been published.

Railroad Crossing

1) Where drain piping pass under a railroad track, the pipe shall be installed in a steel casing. Work within the railroad right-of way shall be subject to the control and requirements of CSX Transportation, Inc. as described in the “Specific Requirements of Consolidated Rail Corporation for Work on its Right-of Way (CE-6, Rev. 2-97)”.

Manhole (See **Detail C-3**)

1) For basic information on manhole materials, refer to **Stormwater Products**.

2) Manholes shall be precast four (4) feet inside diameter for drain pipes up to thirty (30) inches O.D. Manholes shall be five (5) feet inside diameter for drain pipes up to forty four (44) inches O.D.

3) Manholes shall be designed to withstand AASHTO HS-20 loading.

4) Pipes connecting into manholes shall end flush with inside interior wall and all openings around pipe entrances and lift holes shall be filled with non-shrink grout.

5) Manhole covers shall be imprinted with the words “MIT DRAIN” for manholes associated with any drainage system that is entirely owned and maintained by MIT. All manholes associated with any collection system that contributes to a public drainage system shall have covers imprinted with the word “DRAIN.”

6) All drainage manholes shall have a 4 foot deep sump for sediment collection.

Catchbasins (See **Detail C-2**)

1) Pipes connecting into catchbasins shall end flush with inside interior wall and all openings around pipe entrances and lift holes shall be filled with non-shrink grout.

2) For catchbasins located in a paved area, an oil and water separator shall be installed at the outlet pipe. An oil and water separator may be in the form of an elbow down, or a hood specifically manufactured for oil and water separation. The separator shall be removable for periodic flushing and cleaning of drain lines.

3) All Catchbasins shall have a 6 foot deep sump for sediment collection.

Roof Drains

1) Wherever possible, roof drains shall discharge to landscaped areas in order to increase runoff times of concentration and enhance water quality.

2) Roof drain discharges shall in no case be located such that stormwater is routed across walkways or other areas where frozen water would create a safety hazard.

Outfalls

1) Any modifications or additions to MIT owned and operated drainage systems and outfalls will require National Pollutant Discharge Elimination System (NPDES) permitting. MIT currently has one master NPDES permit which governs several outfalls, which should be ammended as required.

2) Any changes or additions in discharges from MIT outfalls could potentially require Cambridge Conservation Commission approval.

Connection to City Stormwater System

All modifications or connections to a public drainage system require review and approval by the Cambridge DPW, and compliance with their latest regulations. At the time of this writing, Cambridge does not have formal regulations. However, the DPW strictly enforces a stormwater policy which is described in detail in the stormwater chapter of "MIT – A Framework for Campus Development."

On-Site Stormwater Management using Best Management Practices (BMPs)

Reference the stormwater chapter of "MIT – A Framework for Campus Development" for a comprehensive discussion of on-site stormwater management, and a menu of BMP's to consider for various parts of campus.

Sanitary Sewer

Pipe

1) For basic information on piping, refer to **Pipe Index**.

2) No single piece of pipe shall be laid unless it is generally straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16-inch per foot of length.

3) Assume minimum trench width of pipe diameter plus 2-feet with a minimum of 3 feet, for sewer pipe installation (See **Typical Pipe Trench Detail C-1**).

4) Slope is to be constant between manholes and be based on a minimum velocity of 2 ft/sec. Following are minimum slopes for PVC pipe (n=0.011):

Size (inches)	*Minimum Slope (ft/foot)*
8	0.0040
10	0.0028
12	0.0022
15	0.0017
18	0.0012
21	0.0010
24	0.0008

Maximum slope is 0.1 ft/foot

5) Sand borrow or crushed stone shall be used as pipe bedding between 6 inches below pipe invert and 6" above pipe crown. Enough crushed stone shall be placed between the pipe and the sides of the trench, and thoroughly compacted, to hold the pipe in correct alignment.

6) Open ends of pipe and branches shall be closed with polyvinyl chloride stoppers secured in place in an acceptable manner.

7) Pipelines shall not be used as conductors for trench drainage during construction.

8) New sewer trunk mains shall be a minimum of 10" in diameter.

9) Where sewer piping pass under a railroad track, the pipe shall be installed in a steel casing. Work within the railroad right-of way shall be subject to the control and requirements of csx transportation, inc. As described in the "specific requirements of consolidated rail corporation for work on its right-of way (ce-6, rev. 2-97)".

Standard Manhole (See **Detail C-12**)

1) For basic information on manhole materials, refer to **Sanitary Sewer Products.**

2) Use 4-foot diameter manholes for pipes up to 24 inches.

3) The precast bases shall be supported on a compacted level foundation of 3/4” crushed stone at least 12-inches thick.

4) All joints between concrete sections shall be watertight.

5) Connection of sewer pipe to manhole shall be made using mechanical connections.

6) Distance between manholes should generally not exceed 400 feet.

7) Manhole frames shall be concentric with top of the manhole and in a full bed of mortar so that the space between the top of the brick and mortar and the bottom of the flange of the frame shall be completely filled and made watertight.

8) The inverts shall conform accurately to the size of the adjoining pipes. Side inverts shall be curved and main inverts shall be laid in smooth curves of the longest possible radius, which is tangent to the centerlines of adjoining sewers.

Drop Manhole (See **Inside Drop Manhole** **(Plan** and **Elevation)** **Detail C-13**)

1) An interior drop manhole should be used when the elevation drop is greater than 2 feet between the pipelines.

Building Service

1) Lateral building services shall be a minimum of 6” in diameter.

Connection to City Sanitary System

1) Connections to the City Sanitary System require a “Sewer Connection Permit” application to be filed with the City of Cambridge DPW.

Ductbanks

1) **Conduits** used in ductbanks are to be 5-inch, round, schedule 40, polyvinyl chloride (PVC). Each single conduit in the ductbank shall be separated and completely encased in concrete (See **Typical Ductbank Detail C-4**).
2) Refer to **Typical Unformed Ductbank Trench Detail C-6** for standard ductbank trench information.
3) Conduits shall be laid at a minimum grade of 3 inches per 100 feet. In no case shall conduits be constructed with low points which will collect water.
4) Ductbanks shall be installed so that the top of the concrete is not less than 30 inches below finished grade at the highest points.
5) Conduits shall terminate in end bells, flush with interior manhole walls, where duct lines enter manholes.
6) During construction and after duct installation, the ends of the conduits shall be plugged to prevent water and debris from entering the conduits or manholes.
7) Joints between conduits and concrete manhole walls shall be made watertight.
8) Conduit joints in concrete encasement may be placed side-by-side horizontally, but shall be staggered at least 6 inches vertically.
9) Duct spacers shall be provided in all duct lines to support and maintain spacing of ducts during concrete pour. Spacers shall be placed on centers not greater than 4 feet.
10) Nylon pull cords shall be installed in empty conduits.
11) Where a proposed ductbank is connecting into an existing structure, core existing vault and use link seals to provide a watertight connection.
12) Where there is potential for water flowing through conduits into a building (as in a siphon action), both ends of the conduits shall be plugged watertight with “Rayflate duct sealing system for power cables” by Raychem Corporation, or approved equal.
13) All ductbanks shall have a spacing of 1 1/2” between conduits and 3” to edges of ductbank. (See **Typical Ductbank Detail C-4**)
14) Where electrical and telecom ducts share a single ductbank, maintain 6” separation filled with solid concrete between conduits of the two utilities.

Vertical and Horizontal alignment

1) Change in vertical or horizontal alignment of a ductbank exceeding a total of 10 degrees shall be long sweep bends having a minimum radius of curvature of 25 feet.
2) Manufactured bends may be used at short runs of 100 feet or less, but only at the end of a run.

3) The sum of bending angles on any single run (between manholes) shall not exceed 180 degrees.

4) Manhole spacing shall not exceed 300 feet.

5) Where telecom and/or electric conduits pass under a railroad track, the conduits should be installed in a steel casing. Work within the railroad right-of way shall be subject to the control and requirements of CSX Transportation, Inc. as described in the "Specific Requirements of Consolidated Rail Corporation for Work on its Right-of Way (CE-6, Rev. 2-97)".

Building Service

1) Where building services enter building foundations, the PVC conduits are to penetrate the wall and either transition to steel conduits or be terminated at pull boxes. The area around the conduits is to be sealed with grout. Conduit wall seals are not required.

Manholes/Vaults (See **Detail C-5**)

1) The interior dimensions of a manhole shall be 6 ft by 9 ft by the required depth. Pre-cast type manholes are acceptable.

2) Vaults shall be designed to support the loading from piping and appurtenances.

3) Vaults shall be designed to support HS-20 loading and lateral soil pressures above and below groundwater.

4) Manholes shall have a sump pit 1 foot in diameter and 4 inches deep. The manhole floor shall be sloped to the sump 1/4" per foot.

5) Manhole covers shall have the appropriate words "MIT ELECTRICAL" or "MIT TELECOM" cast upon them.

6) The manhole shall be buried a maximum of 1'-6".

Steam and Condensate

Thermal Insulation for Piping (above ground)

Thermally insulate all hot lines and surfaces, unless otherwise excepted. Completely insulate all system components and surfaces including, without limitation, piping, valves, valve bonnets, flanges, strainers, fittings, expansion joints, special valves, control valves and cocks. Insulation thickness shall be based on a 40-year life cycle cost basis.

A. Work in Concrete Trenches: Wrap and protect insulation with two layers or 15 pound roofing felt attached with 16 gauge copper wire bands at 9" on center. Piping in trenches should be insulated with foamglass (such as Stratafab) and wrapped with mastic (such as Pit Wrap).

B. Steam and condensate piping in manholes shall be insulated with calcium silicate and covered with an aluminum jacket.

C. Refer to the following typical details and schedules for the Thermal Insulation for Piping installation practices:

M — 1	**Exterior Above Ground Insulation Installation Detail**
M -- 12	**Cross Section of Steam Supply and Condensate Return**
M -- 19	**Field Closure Kit Assembly**
S – 3	**Thickness of Pipe Insulation (Fiberglass)**

Waterproofing for Trench Covers and Manhole Roofs

Provide a complete waterproofing system over the entire top and extending down at least 12" on all sides.

A. Acceptable Waterproofing System: Provide Essen Chemical Corporation, Baltimore, Maryland, fiberglass reinforced troweled mastic waterproofing system consisting of "Webtex 350" mastic with fiberglass reinforcing thoroughly embedded in the mastic. Overlap joints in fiberglass reinforcing at least 6". Provide 8" wide bond breaker strips of roofing felt over major cracks and joints in the substrate.

Exterior Wall Piping Penetrations

Seal all exterior wall piping penetrations above and below grade with "Link Seals" by Thunderline Corporation, Wayne, Michigan. Comply with manufacturer's sizing recommendations for size of pipe passing through. Seals may be made directly against concrete, but provide waterproofed steel sleeves for materials other than concrete.

A Refer to the following typical details for the Exterior Wall Piping Penetrations installation practices:

M – 13	**Gland Seal Assembly**
M – 14	**Wall Penetration Detail for Underground Steam and CR Conduit Pipe**
M – 15	**Hot Pipe Penetration Detail**
M – 17	**Condensate End Seal Assembly**

Pipe Materials and Installation Guidelines

1. For basic general information on piping, pipe fittings and valves refer to the **Piping Index**.

2. Comply with the general installation requirements.

A. Refer to the following typical details for the Pipe Installation Guidelines:

M – 2 **Typical Pipe Slide Detal**
M – 3 **Typical Pipe Guide Detail**
M – 4 **Typical Pipe Anchor Detail**
M – 5 **Pipe Hanger Support**
M – 6 **Single Pipe Support**
M – 7 **Multiple Pipe Support**
M – 8 **Standard Anchor Assembly**
M - 9 **Elbow Assembly**
M – 10 **Valve Vault Vent Gooseneck Detail**
C – 1 **Pipe Bedding & Backfill**

Steam Traps

Provide traps to hold steam in a heating apparatus or piping system and allow condensate and air to pass. Provide steam traps based on pipe class:

CLASS	SIZE	STANDARD	SPECIFICATION
150	All		Steel; 300# rating; inverted bucket type; Armstrong 310.
150L	All		Cast iron; float and thermostatic type for 15 psig and below; Armstrong 1010.
300	All		Cast or forged steel; 300# rating; inverted bucket type; Armstrong310.

A. Refer to the following typical details for the Steam Traps installation practices:

M – 11 Dirt Leg and Steam Trap Detail
M – 18 Steam Trap Discharge Flash Arrestor

Support Load Tables

A. Refer to the following typical schedules for the Support Load Tables:

S – 1 Variable Spring Support Load Table
S – 2 Pipe Support Load Table

Hot Water Piping

Thermal Insulation for Piping (above ground)

Thermally insulate all hot lines and surfaces, unless otherwise excepted. Completely insulate all system components and surfaces including, without limitation, piping, valves, valve bonnets, flanges, strainers, fittings, expansion joints, special valves, control valves and cocks. Insulation thickness shall be based on a 40-year life cycle cost basis.

A. Work in Concrete Trenches: Wrap and protect insulation with two layers or 15 pound roofing felt attached with 16 gauge copper wire bands at 9" on center. Piping in trenches should be insulated with foamglass (such as Stratafab) and wrapped with mastic (such as Pit Wrap).

B. Refer to the following typical details and schedules for the *Thermal Insulation for Piping* installation practices:

M – 1 Exterior Above Ground Insulation Installation Detail
S – 3 Thickness of Pipe Insulation (Fiberglass)

Exterior Wall Piping Penetrations

Refer to the following typical details for the *Exterior Wall Piping Penetrations* installation practices:

M – 15 Hot Pipe Penetration Detail
M – 16 Hot Water Foundation Wall Penetration Detail.

Pipe Materials and Installation Guidelines

1. For basic general information on piping, pipe fittings and valves refer to the **Pipe Index**.

2. Comply with the general installation requirements.

A. Refer to the following typical details for the Pipe Installation Guidelines:

M – 5 Pipe Hanger Support
M – 6 Single Pipe Support
M – 7 Multiple Pipe Support
C – 1 Pipe Bedding & Backfill

Chilled Water Piping

Thermal Insulation for Piping

Thermally insulate above ground lines and surfaces, unless otherwise excepted. Completely insulate all system components and surfaces including, without limitation, piping, valves, valve bonnets, flanges, strainers, fittings, expansion joints, special valves, control valves and cocks. Insulation thickness shall be based on a 40-year life cycle cost basis.

A. Low Temperature Piping: Provide insulation manufacturer's standard vapor barrier and flame retardant finish. Place support hangers on outside of insulation.

B. Work in Concrete Trenches: Wrap and protect insulation with two layers or 15 pound roofing felt attached with 16 gauge copper wire bands at 9" on center. Piping in trenches should be insulated with foamglass (such as Stratafab) and wrapped with mastic (such as Pit Wrap).

C. Refer to the following typical details and schedules for the *Thermal Insulation for Piping* installation practices:

M – 1 Exterior Above Ground Insulation Installation Detail
S – 3 Thickness of Pipe Insulation (Fiberglass)

Exterior Wall Piping Penetrations

Seal all exterior wall piping penetrations above and below grade with "Link Seals" by Thunderline Corporation, Wayne, Michigan. Comply with manufacturer's sizing recommendations for size of pipe passing through. Seals may be made directly against concrete, but provide waterproofed steel sleeves for materials other than concrete.

A. Refer to the following typical details for the *Exterior Wall Piping Penetrations* installation practices:

M – 21 Seal Assembly

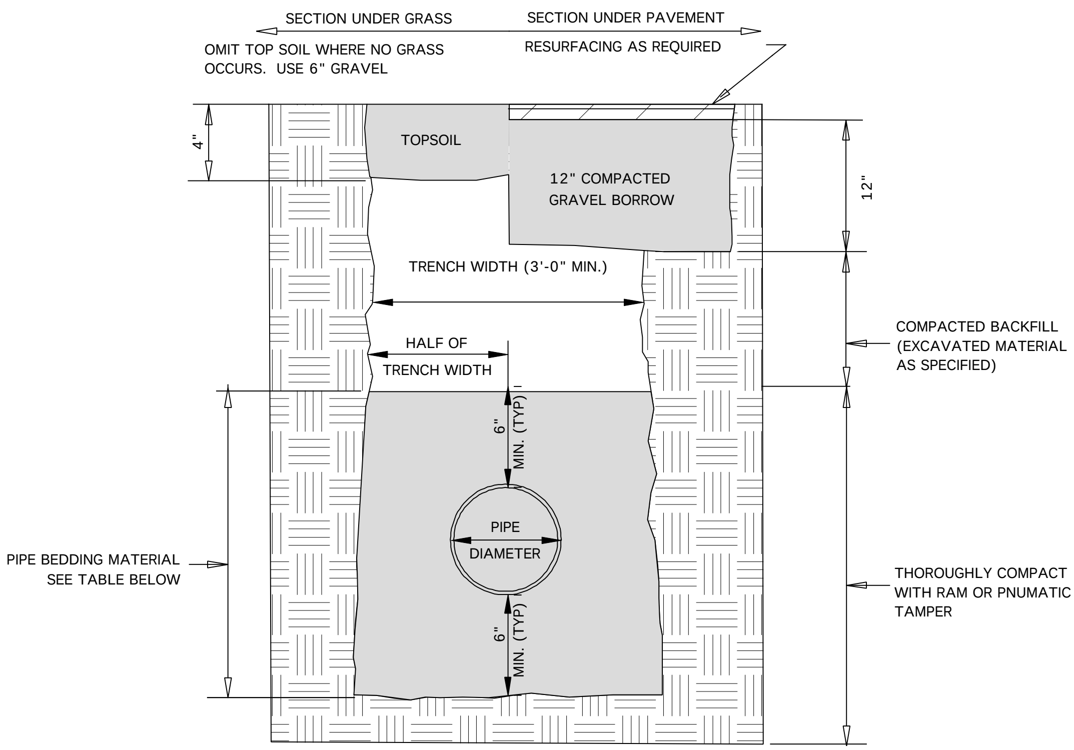
Pipe Materials and Installation Guidelines

1. For basic general information on piping, pipe fittings and valves refer to the **Piping Index**:

2. Comply with the general installation requirements.

A. Refer to the following typical details for the pipe installation guidelines

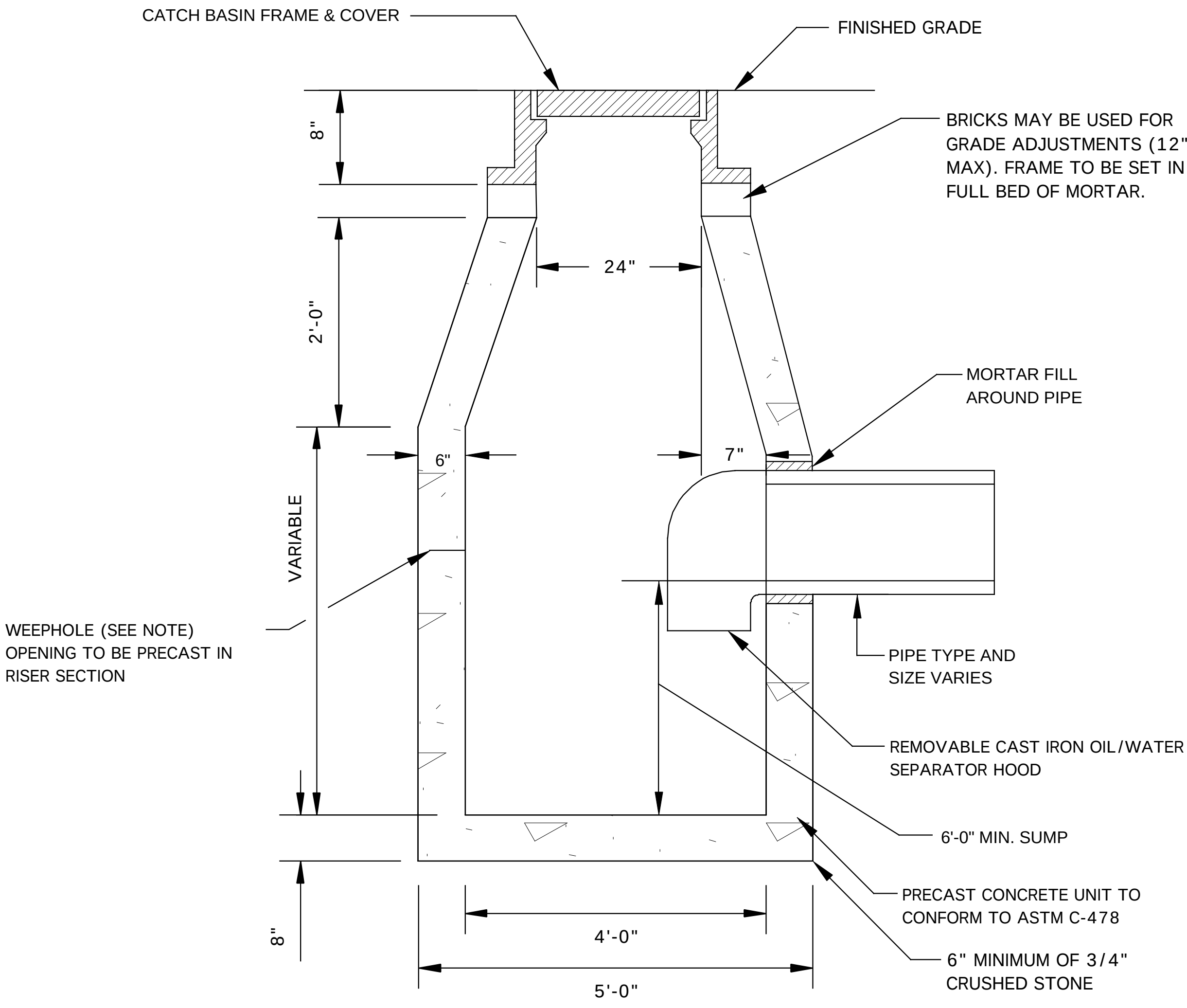
M – 5 Pipe Hanger Support
M – 6 Single Pipe Support
M – 7 Multiple Pipe Support



UTILITY	BEDDING MATERIAL
STEAM/CONDENSATE	SAND
HOT WATER	SAND
CHILLED WATER	CRUSHED STONE
DOMESTIC WATER	SAND OR CRUSHED STONE
FIRE PROTECTION	SAND
STORM DRAIN	SCREENED GRAVEL OR CRUSHED STONE
SANITARY SEWER	SAND OR CRUSHED STONE

C-1	TYPICAL PIPE TRENCH DETAIL	NTS

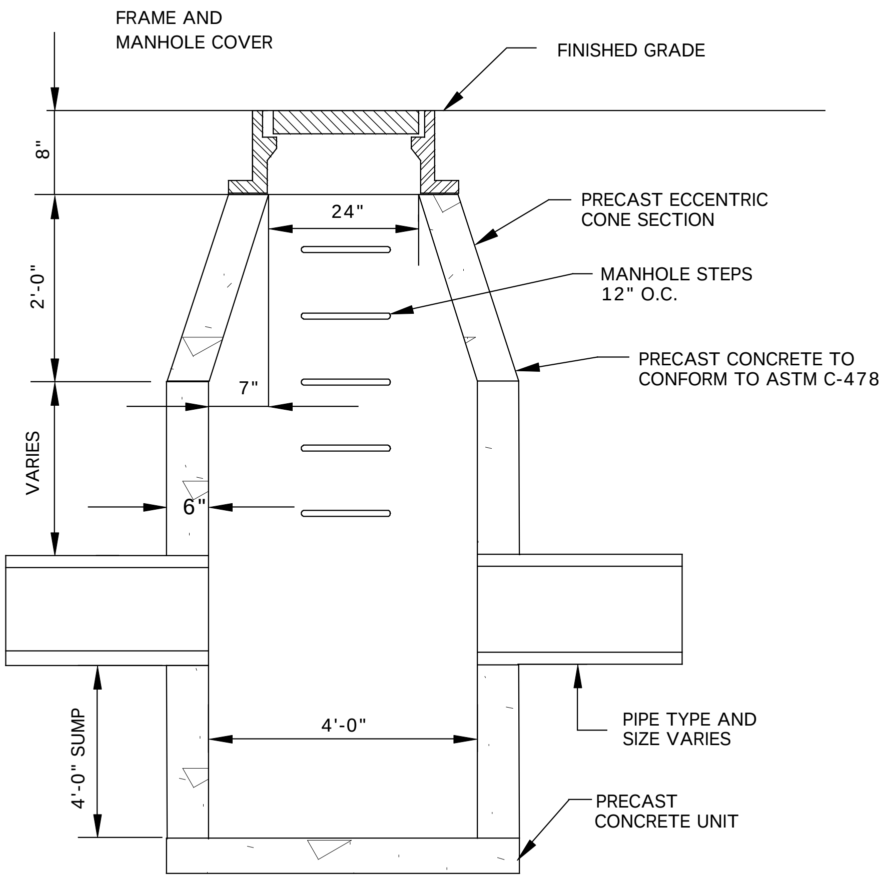
(back to text)



NOTE:
WEEPHOLES SHALL NOT BE PROVIDED IN AREAS OF CONTAMINATION OR HIGH GROUNDWATER.

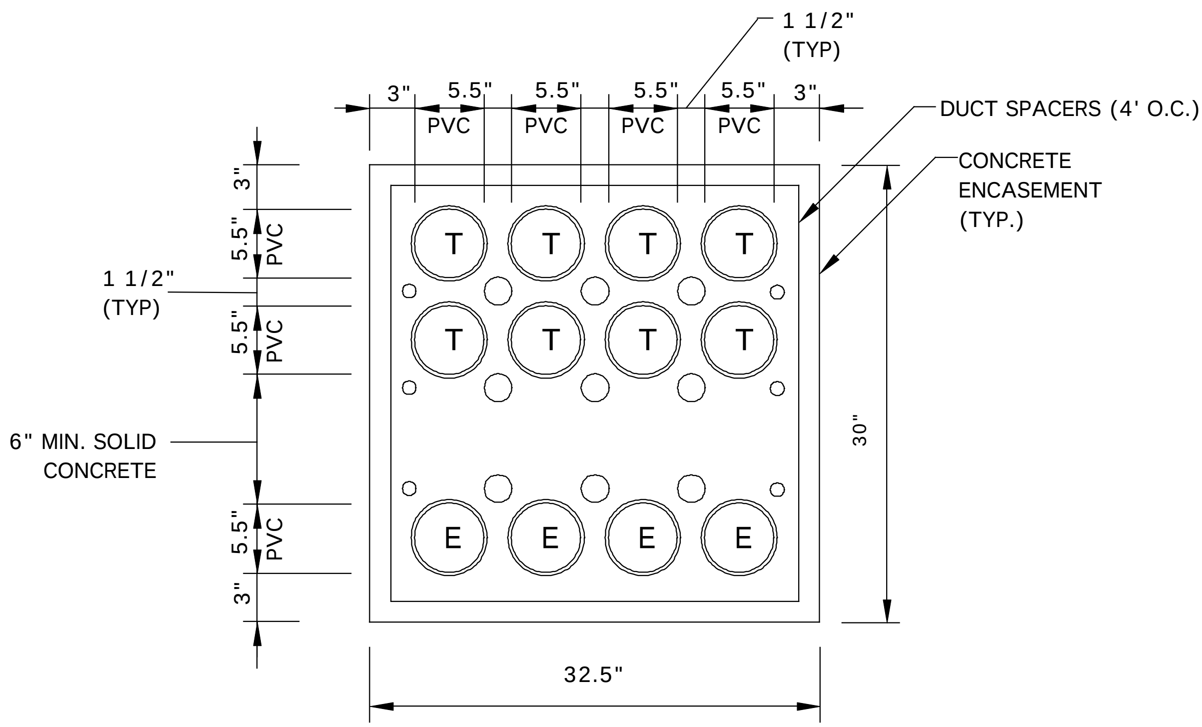
C-2	PRECAST CONCRETE CATCH BASIN	NTS

(back to text)



C-3	PRECAST CONCRETE DRAIN MANHOLE	NTS

(back to text)

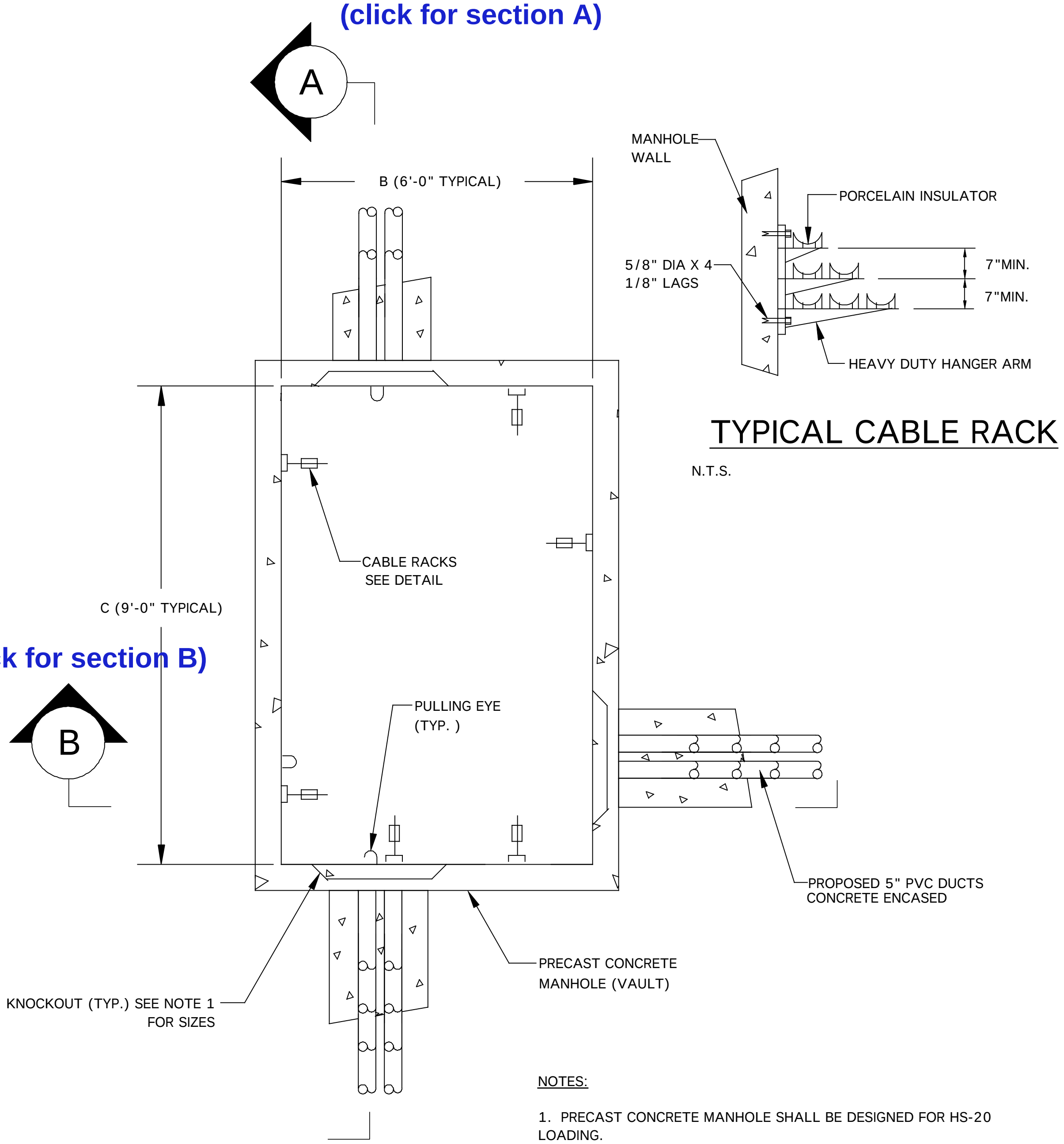


C-4	TYPICAL DUCTBANK	NTS

(back to text)

(click for section A)

(click for section B)



TYPICAL CABLE RACK

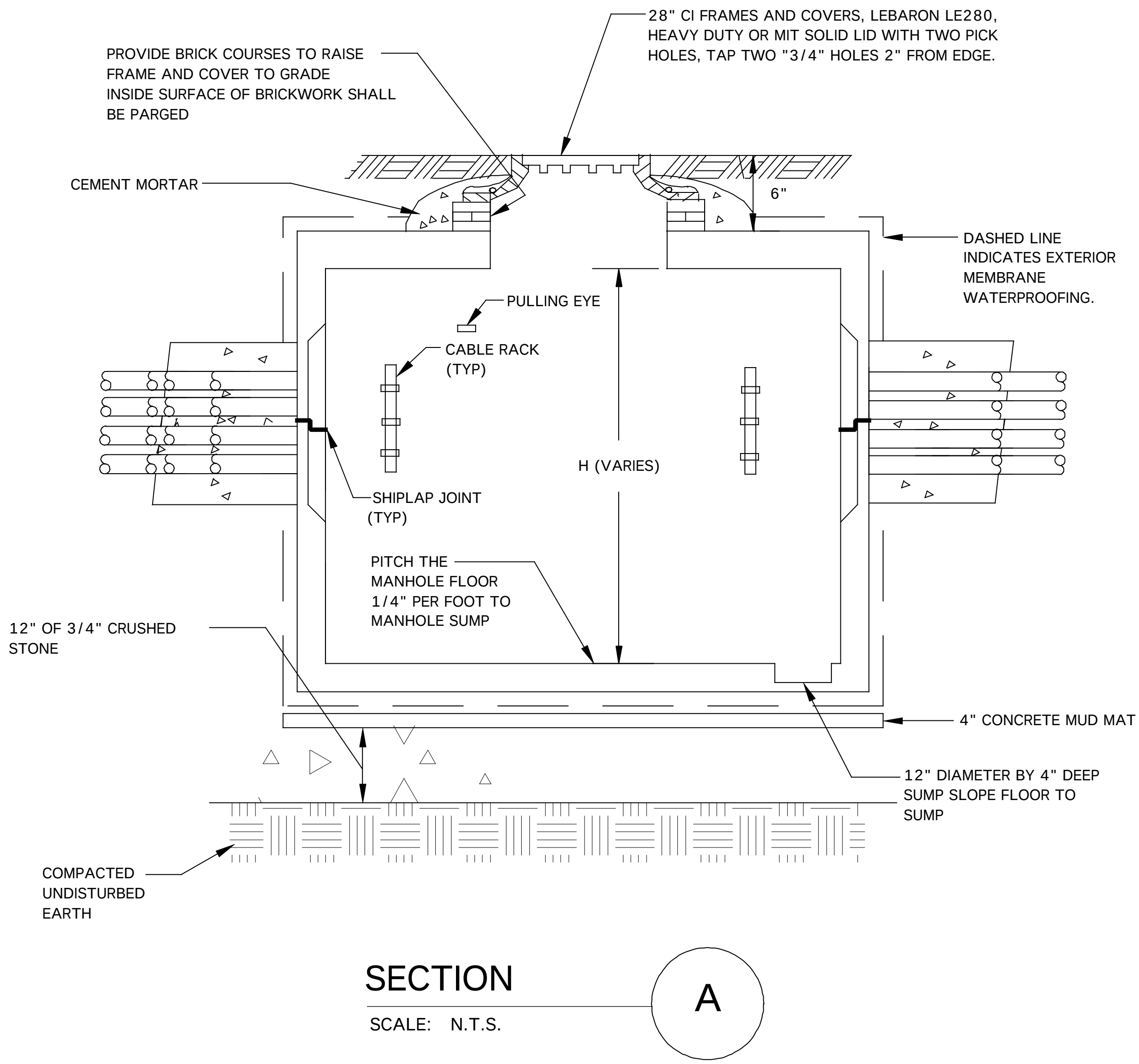
N.T.S.

NOTES:

1. PRECAST CONCRETE MANHOLE SHALL BE DESIGNED FOR HS-20 LOADING.
2. ENTIRE MANHOLE SHALL BE COATED WITH BITUMINOUS DAMPPROOFING.
3. ELEVATIONS AND DIMENSIONS OF KNOCKOUTS VARY.
4. ALL DUCTBANKS SHALL BE GROUTED TO MANHOLE.

C-5	TYPICAL ELECTRICAL/ TELECOMMUNICATION MANHOLE PLAN	NTS

(back to text)

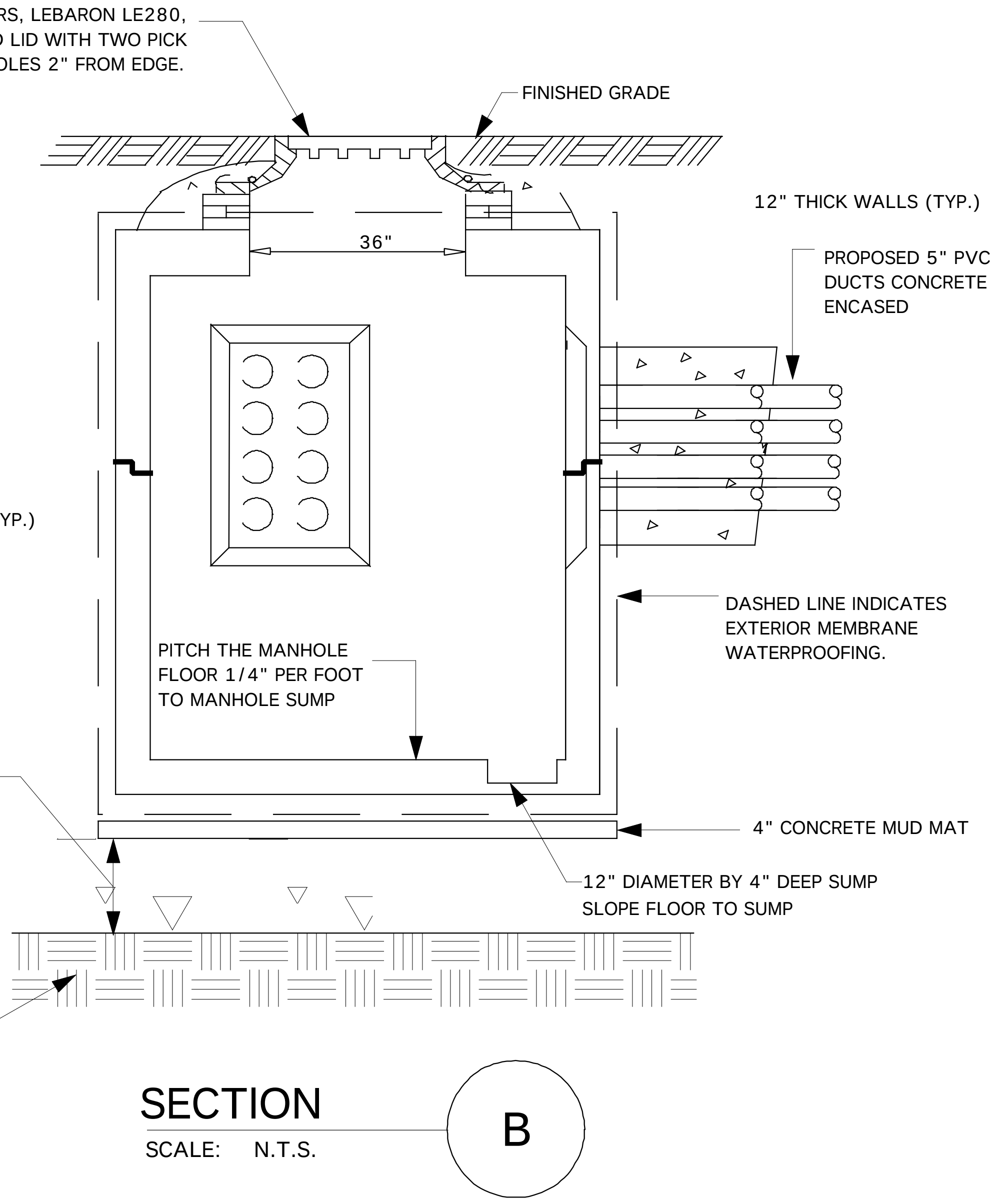


TYPICAL ELECTRICAL/ TELECOMMUNICATION MANHOLE SECTION

NTS

(click for plan)

(back to text)

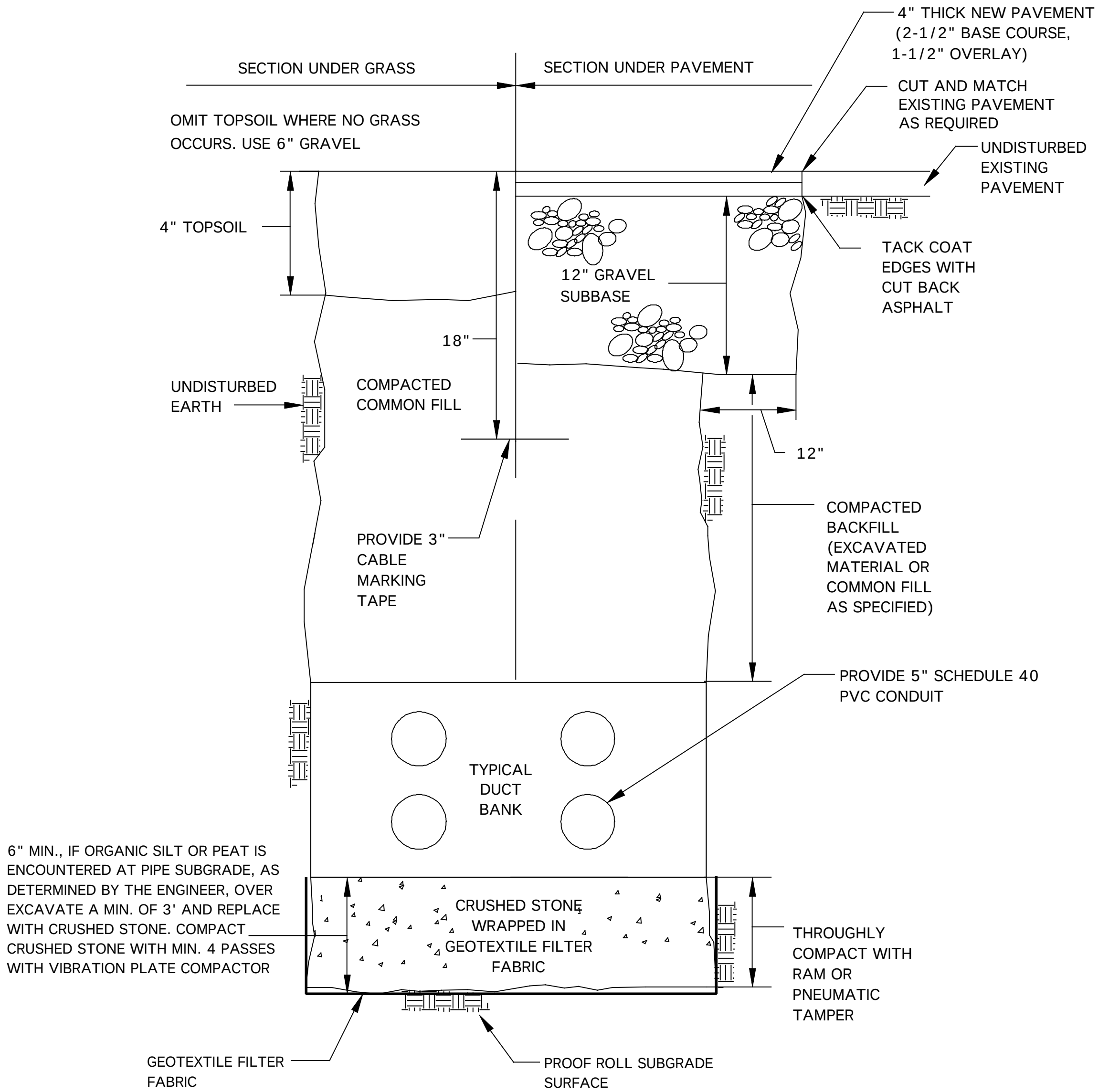


TYPICAL ELECTRICAL/ TELECOMMUNICATION MANHOLE SECTION

NTS

(click for plan)

(back to text)



C-6	TYPICAL UNFORMED DUCTBANK TRENCH DETAIL	NTS

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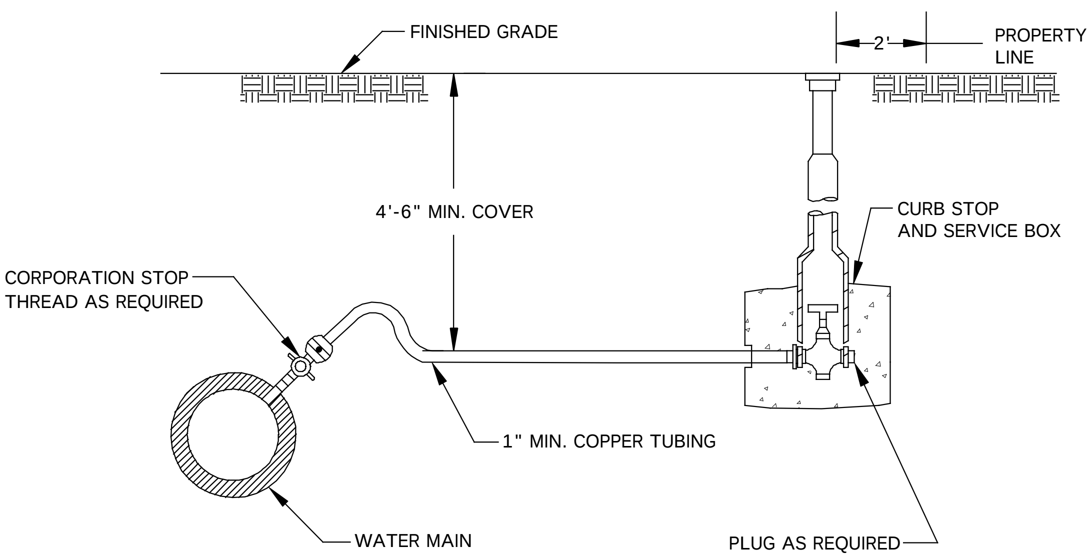

C-7	WATER SERVICE	NTS

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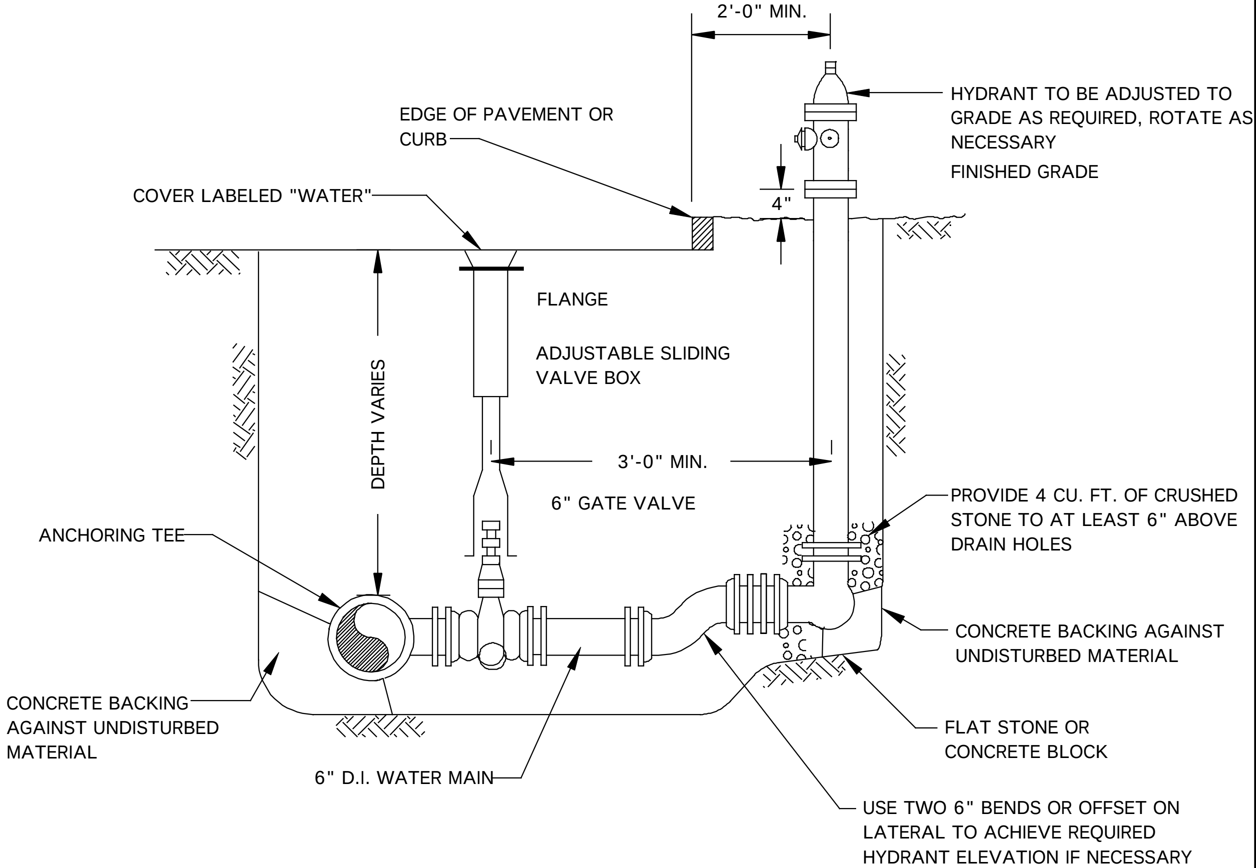

C-8	HYDRANT AND VALVE	NTS

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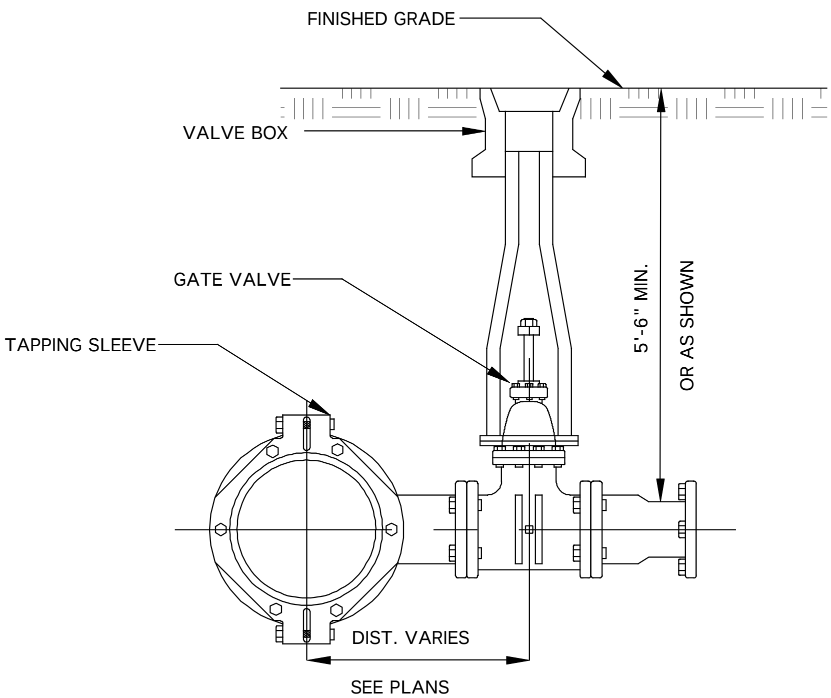
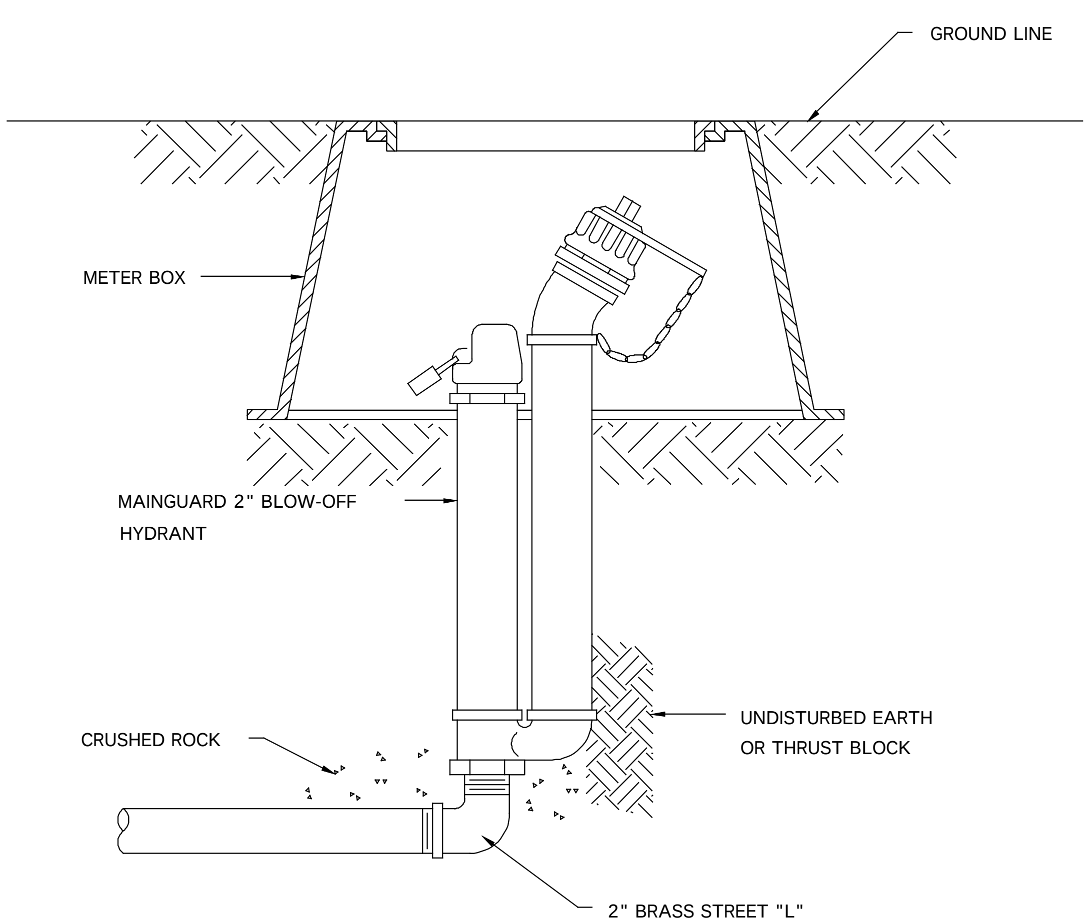


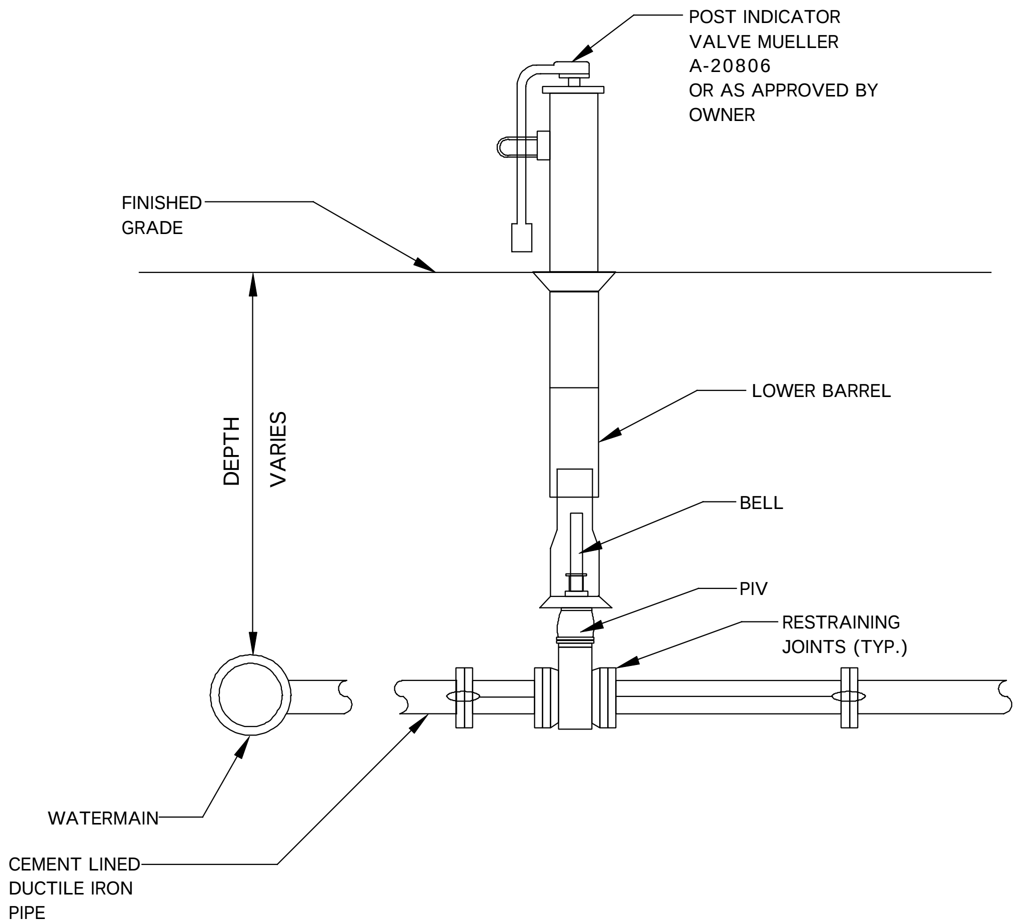
C-9	TAPPING SLEEVE AND VALVE	NTS

(back to text)



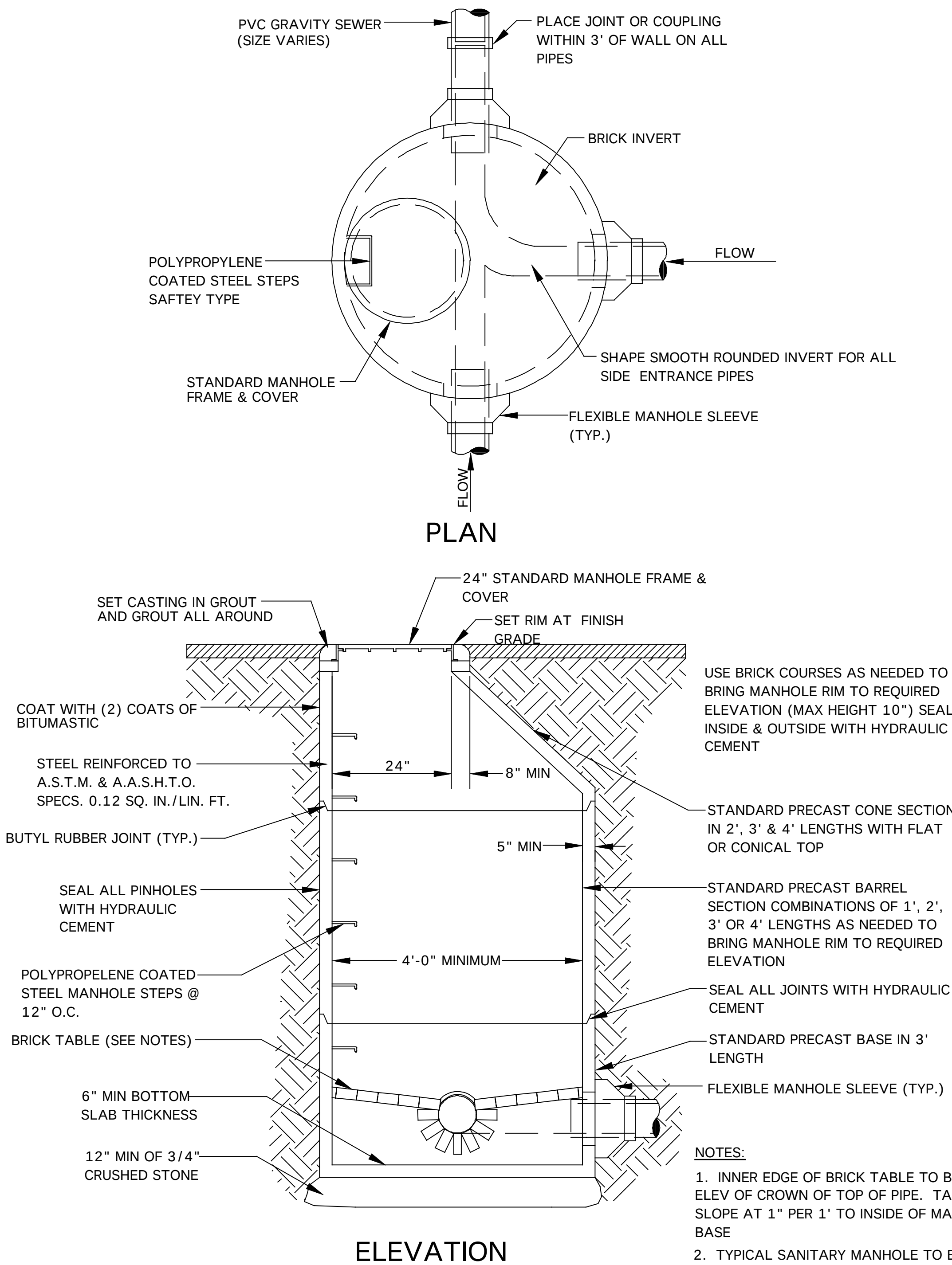
C-10	BLOW-OFF HYDRANT	NTS

(back to text)



C-11	POST INDICATOR VALVE	NTS

(back to text)

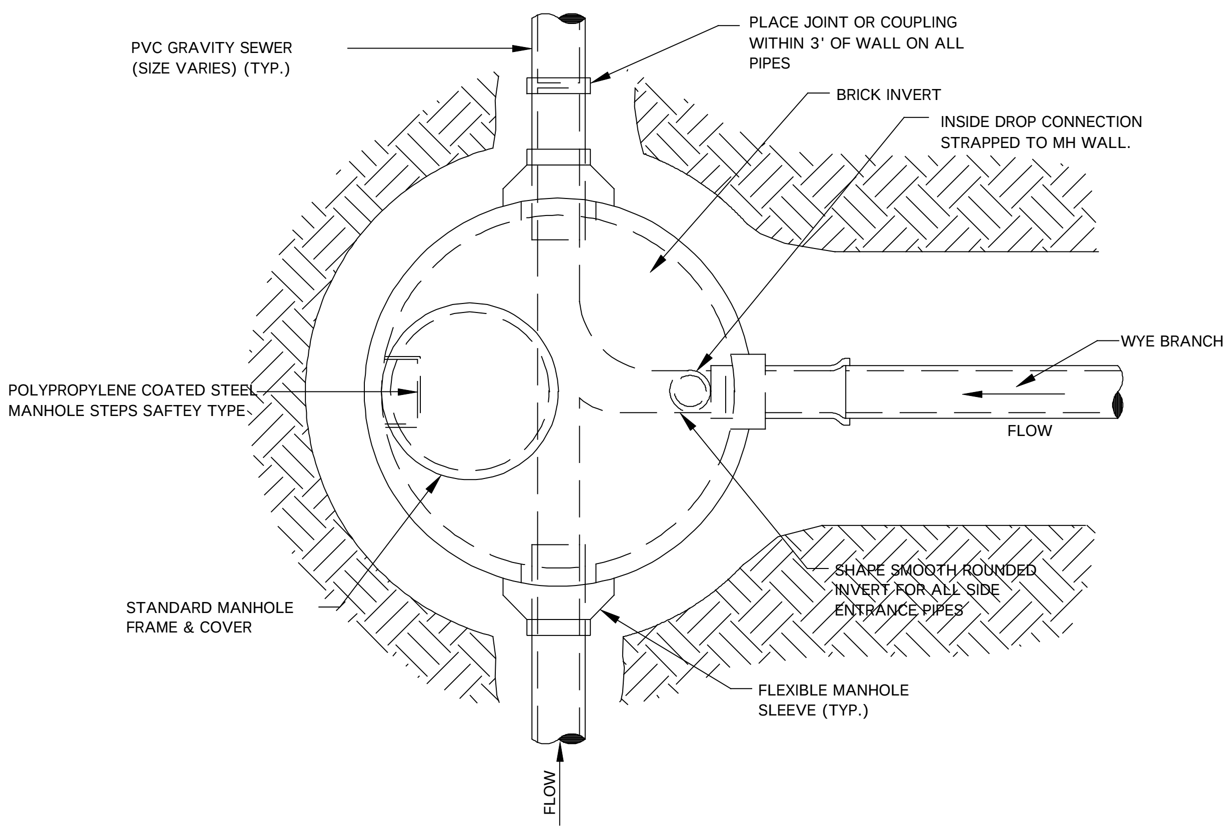


NOTES:

1. INNER EDGE OF BRICK TABLE TO BE AT ELEV OF CROWN OF TOP OF PIPE. TABLE TO SLOPE AT 1" PER 1' TO INSIDE OF MANHOLE BASE
2. TYPICAL SANITARY MANHOLE TO BE 4 FT. DIA.

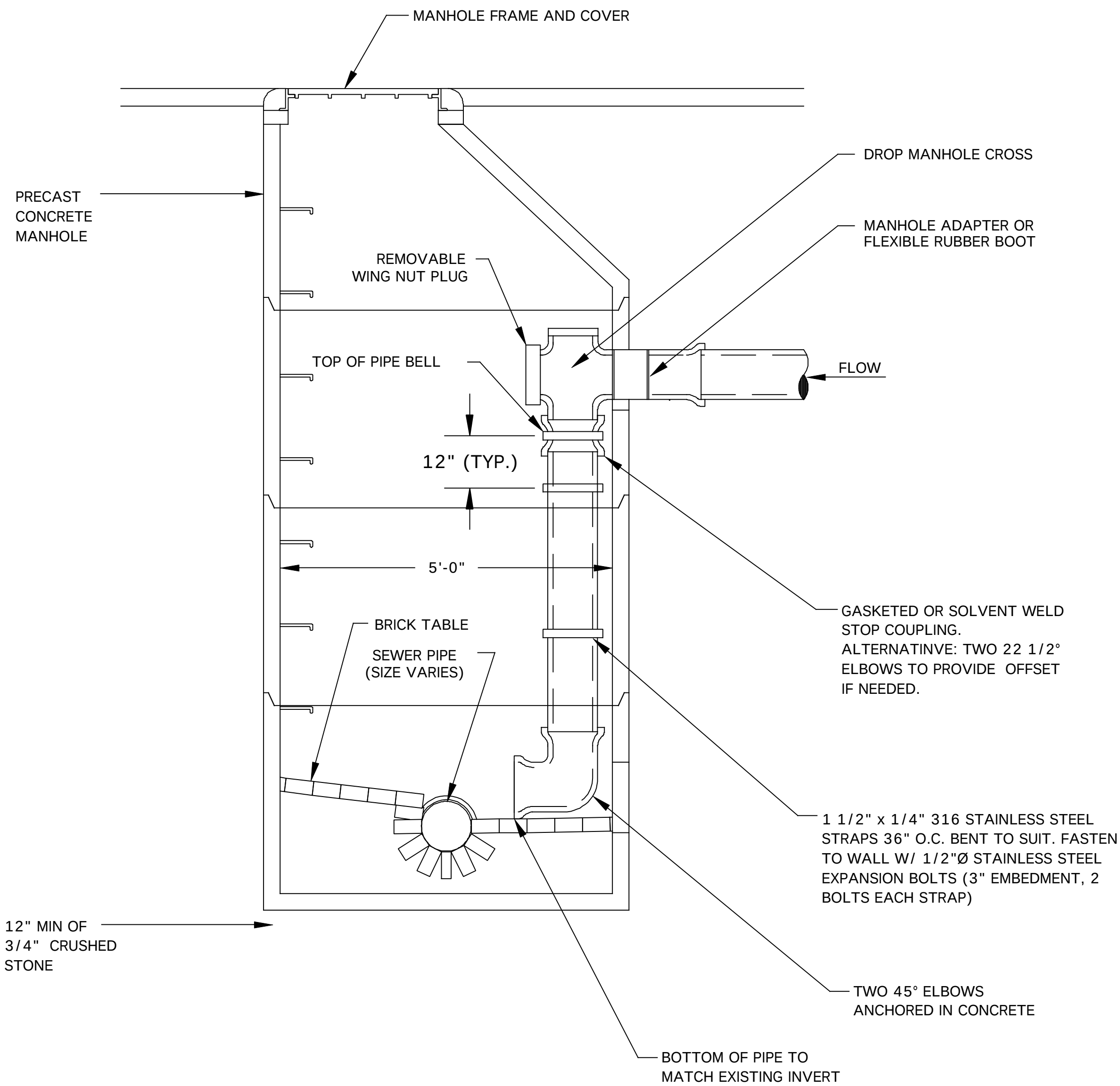
C-12	TYPICAL SANITARY SEWER MANHOLE	NTS

(back to text)



C-13	INSIDE DROP MANHOLE (PLAN) **(click for elevation)**	NTS

(back to text)

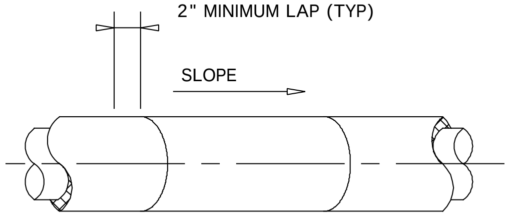


NOTES:

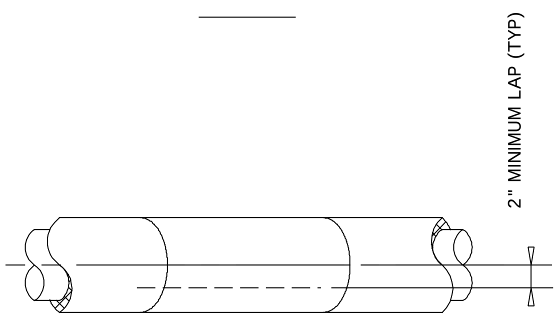
1. DROP MANHOLES SHALL BE USED WHEN ENTRANCE PIPE INVERTS ARE 2' OR GREATER THAN MANHOLE INVERT.

INSIDE DROP MANHOLE (ELEVATION) **(click for plan)**	NTS

(back to text)



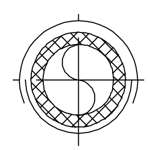
PLAN



ELEVATION

NOTES:

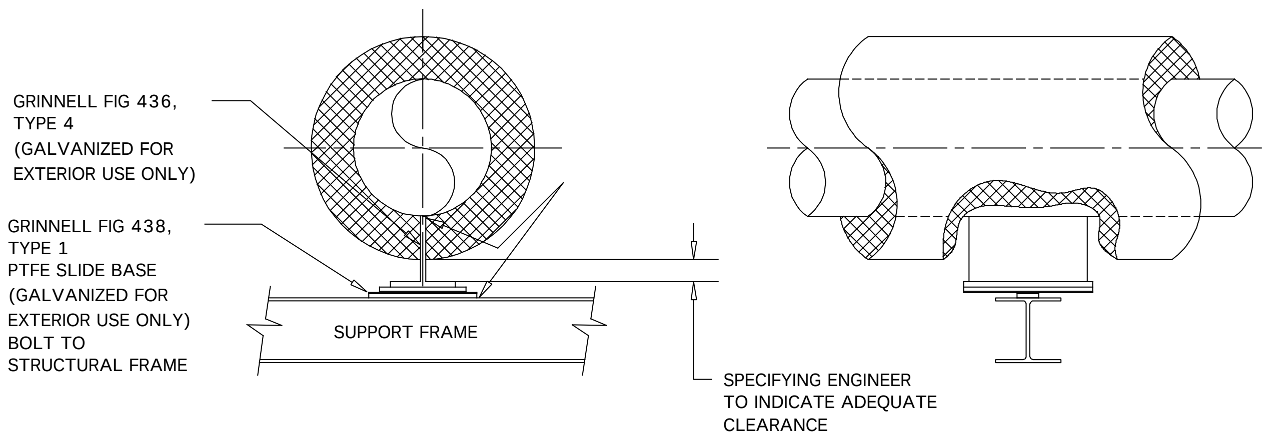
1. HYDROUS CALCIUM SILICATE PIPE INSULATION: THERMO-12/GOLD MEETING ASTM C 533, TYPE1; RIGID MOLDED PIPE; ASBESTOS-FREE COLOR CODED THROUGHOUT MATERIAL THICKNESS.
2. COMPRESSIVE STRENGTH: MINIMUM OF 100 PSI.
3. TIE WIRE: 16 GAGE (0.045mm) STAINLESS STEEL WITH TWISTED ENDS ON MAXIMUM 12 INCH (300mm) CENTERS.
4. ALUMINUM JACKET: 0.016 INCH (0.045 mm) THICK SHEET, (EMBOSSED) FINISH, WITH LONGITUDINAL SLIP JOINTS AND 2 INCH (50mm) LAPS, DIE SHAPED FITTING COVERS WITH FACTORY APPLIED MOISTURE BARRIER. STAINLESS STEEL BANDS MINIMUM EVERY 12" O.C.



END

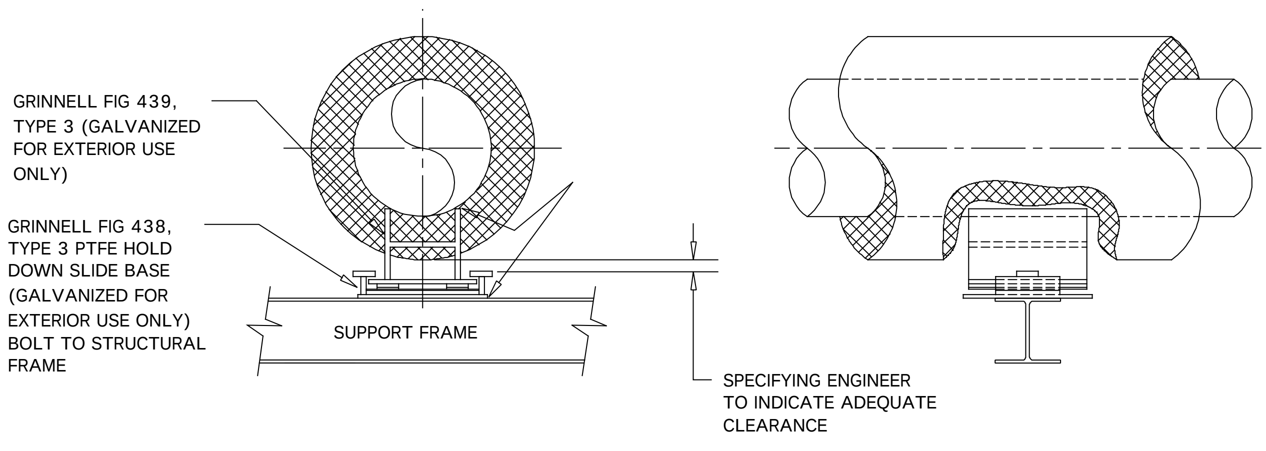
M-1	EXTERIOR ABOVE GROUND INSULATION INSTALLATION DETAIL	NTS

(back to text)



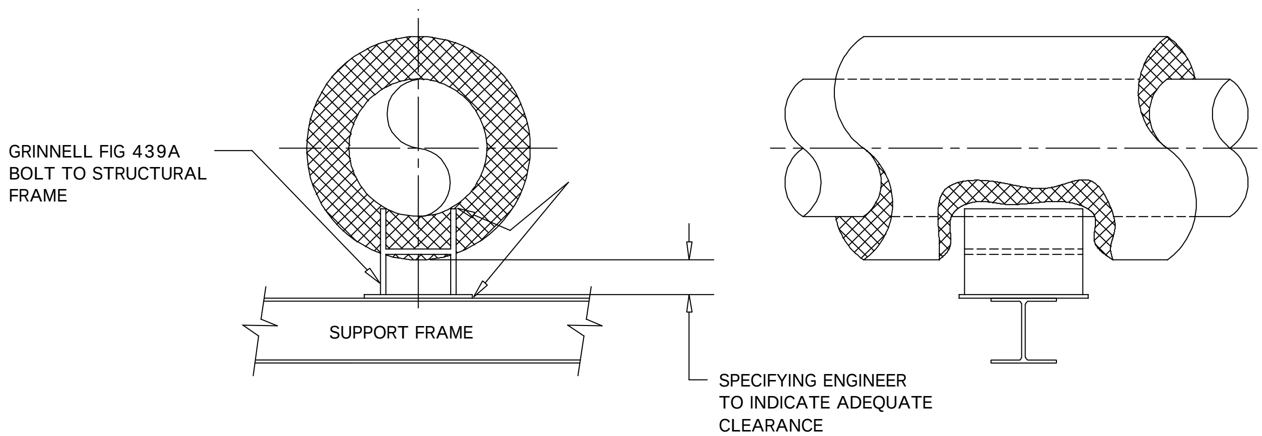
M-2	TYPICAL PIPE SLIDE DETAIL	NTS

(back to text)



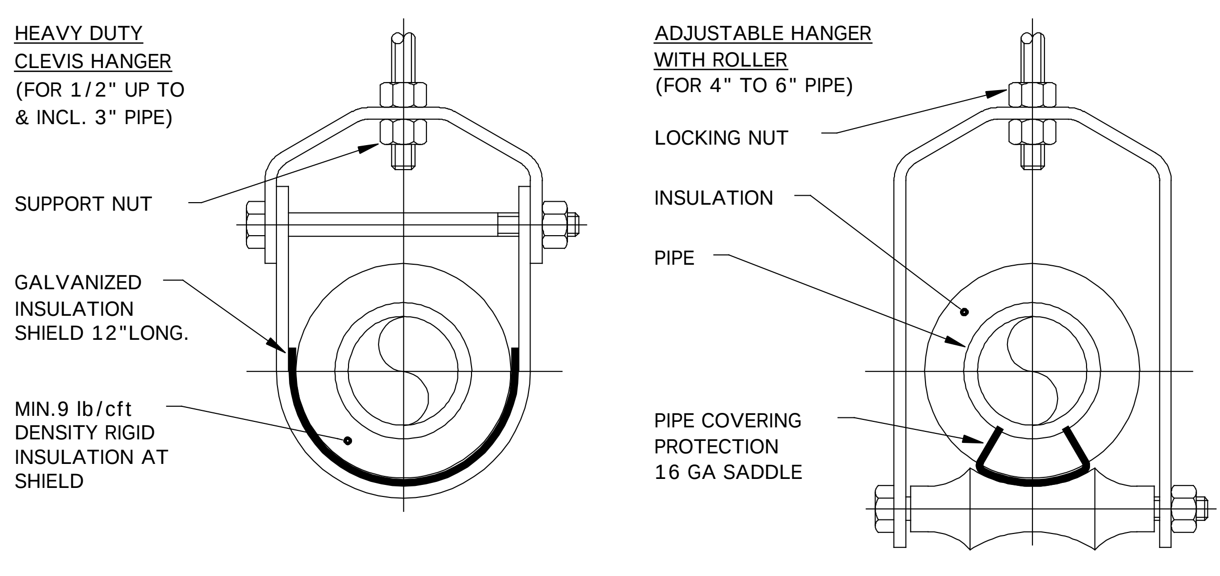
M-3	TYPICAL PIPE GUIDE DETAIL	NTS

(back to text)



M-4	TYPICAL PIPE ANCHOR DETAIL	NTS

(back to text)

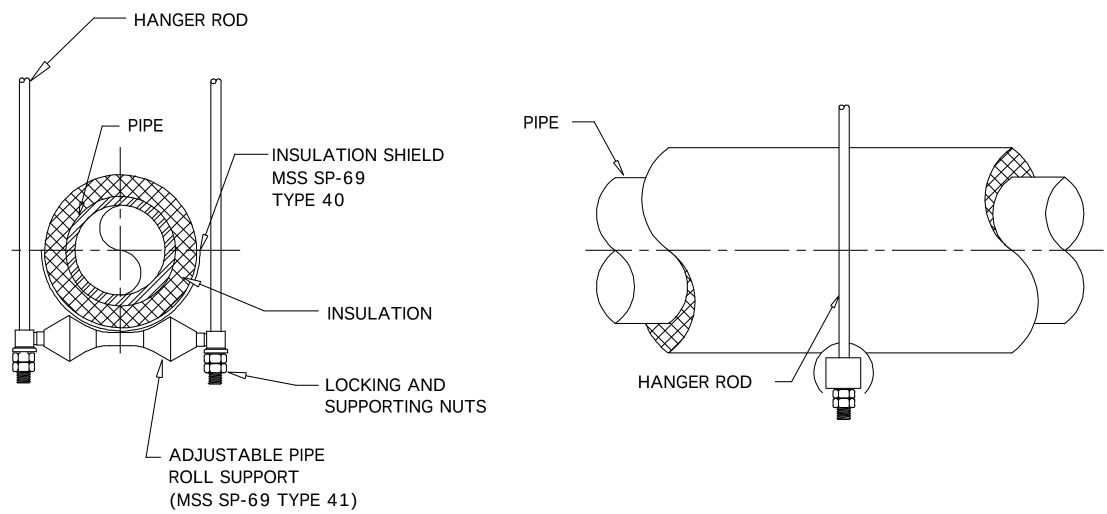


NOTES:

1. SPECIFYING ENGINEER TO PROVIDE SPECIFICATIONS FOR HANGER SIZES.
2. PIPE 8" AND LARGER SHALL HAVE ROLLER SUPPORTED WITH DUAL RODS.

M-5	PIPE HANGER SUPPORT	NTS

(back to text)

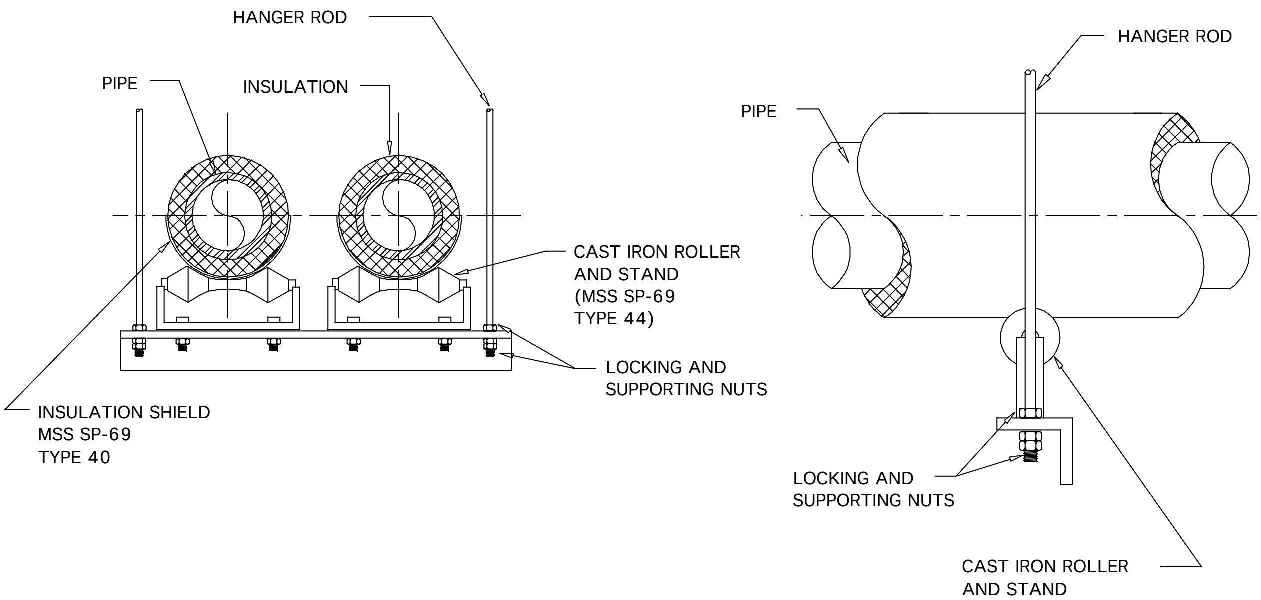


NOTES:

1. SPECIFYING ENGINEER TO PROVIDE DETAIL FOR INSULATION SYSTEM AT POINT OF SUPPORT.
2. ROLLER ASSEMBLY MAY BE FLOOR SUPPORTED USING ADJUSTABLE PIPE ROLL STAND (MSS SP-69 TYPE 46) OR APPROVED EQUAL.

M-6	SINGLE PIPE SUPPORT	NTS

(back to text)

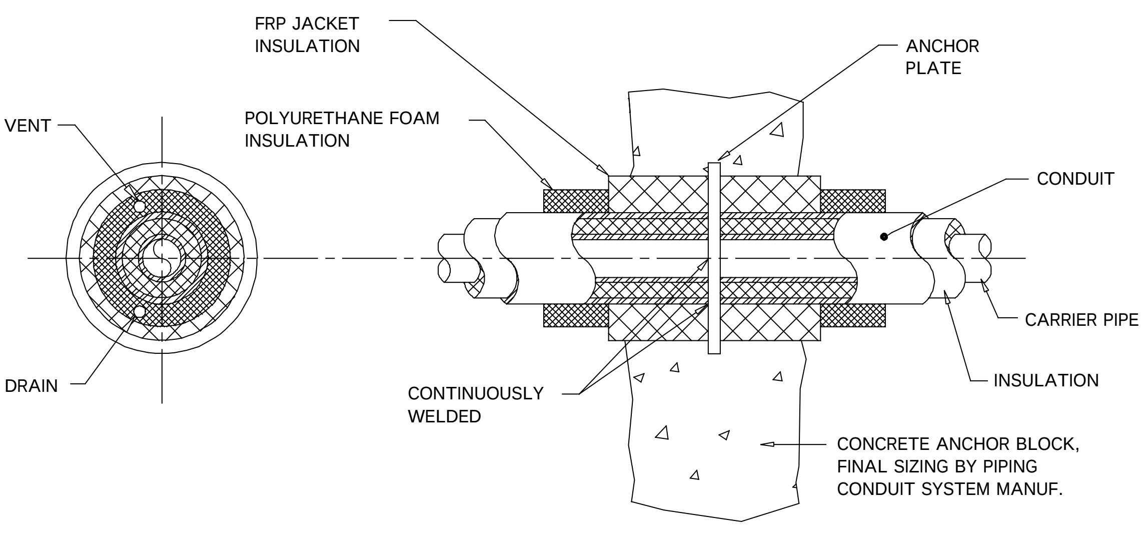


NOTES:

1. SPECIFYING ENGINEER TO PROVIDE DETAIL FOR INSULATION SYSTEM AT POINT OF SUPPORT.
2. ROLLER ASSEMBLY MAY BE FLOOR SUPPORTED USING ADJUSTABLE PIPE. ROLL STAND (MSS SP-69 TYPE 46) OR APPROVED EQUAL.

M-7	MULTIPLE PIPE SUPPORT	NTS

(back to text)

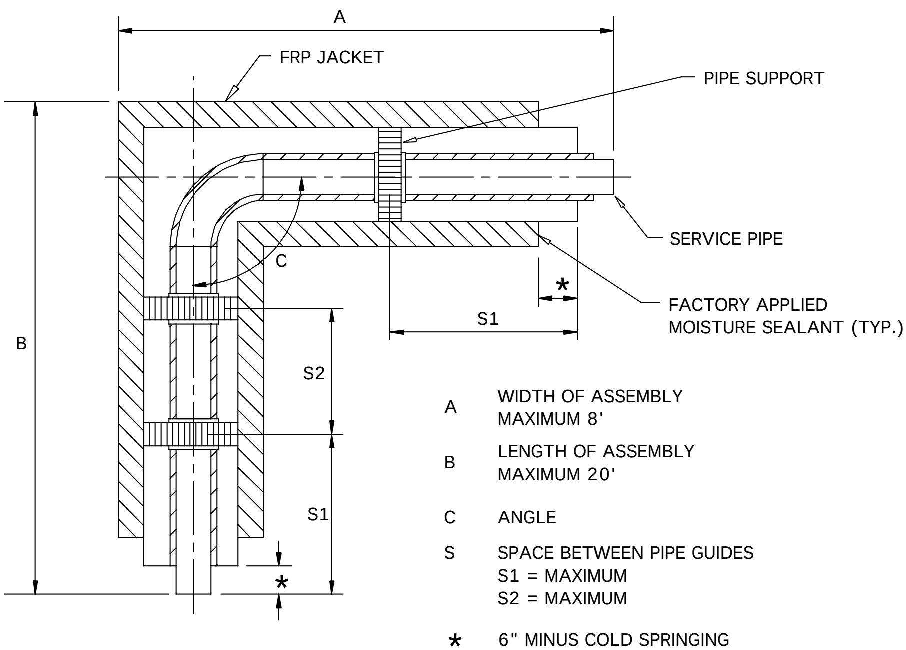


NOTES:

1. ANCHOR PLATE THICKNESS SHALL BE 1/2" UP TO 22" CONDUIT SIZE AND 3/4" FOR CONDUITS LARGER THAN 24".
2. PROVIDE REBAR IN ANCHOR BLOCK, ATTACHED TO ANCHOR PLATE, AS NECESSARY.

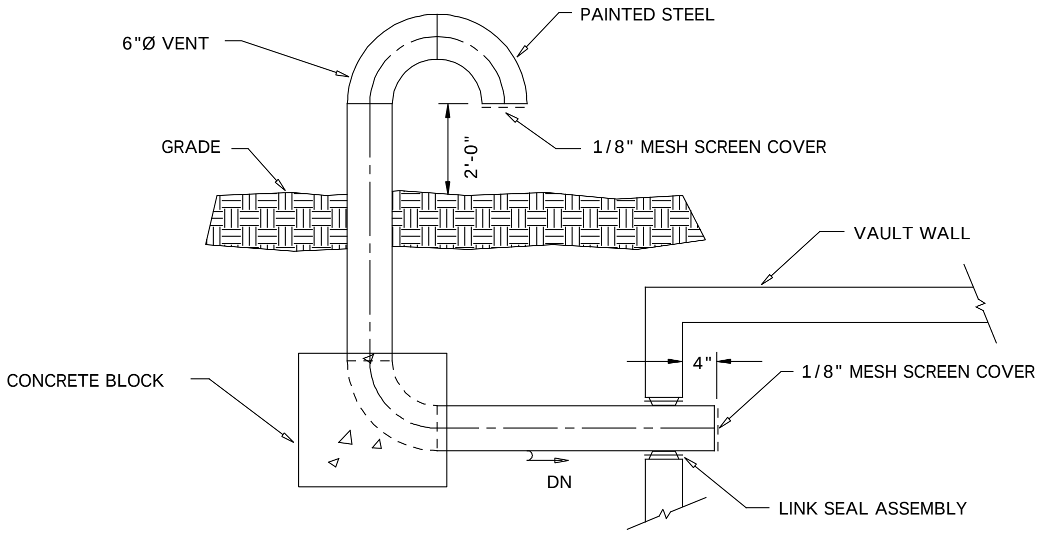
M-8	STANDARD ANCHOR ASSEMBLY	NTS

(back to text)



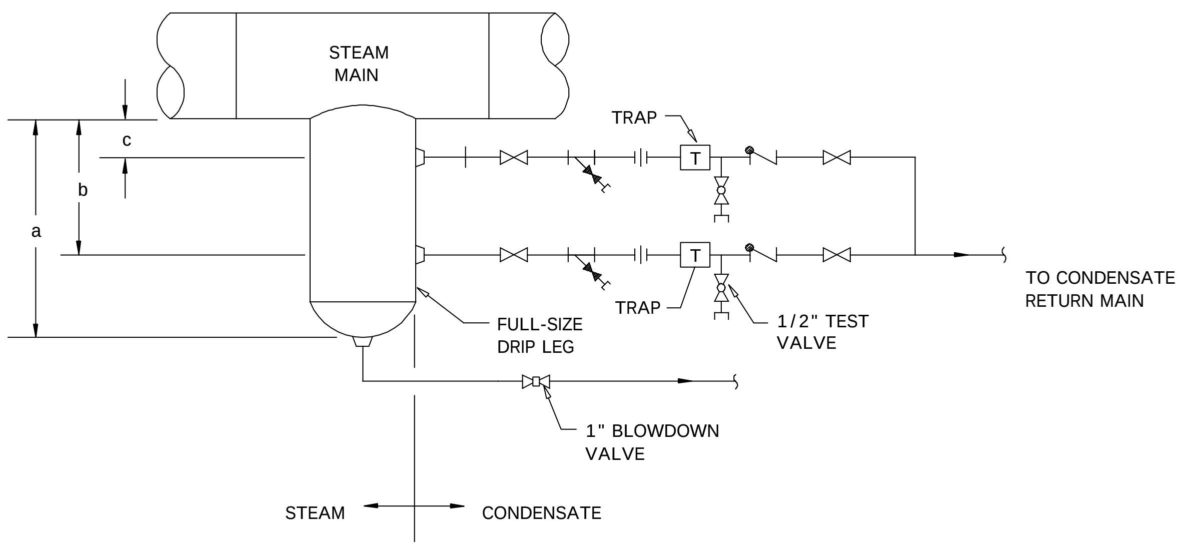
M-9	ELBOW ASSEMBLY	NTS

(back to text)



M-10	VALVE VAULT VENT GOOSENECK DETAIL	NTS

(back to text)

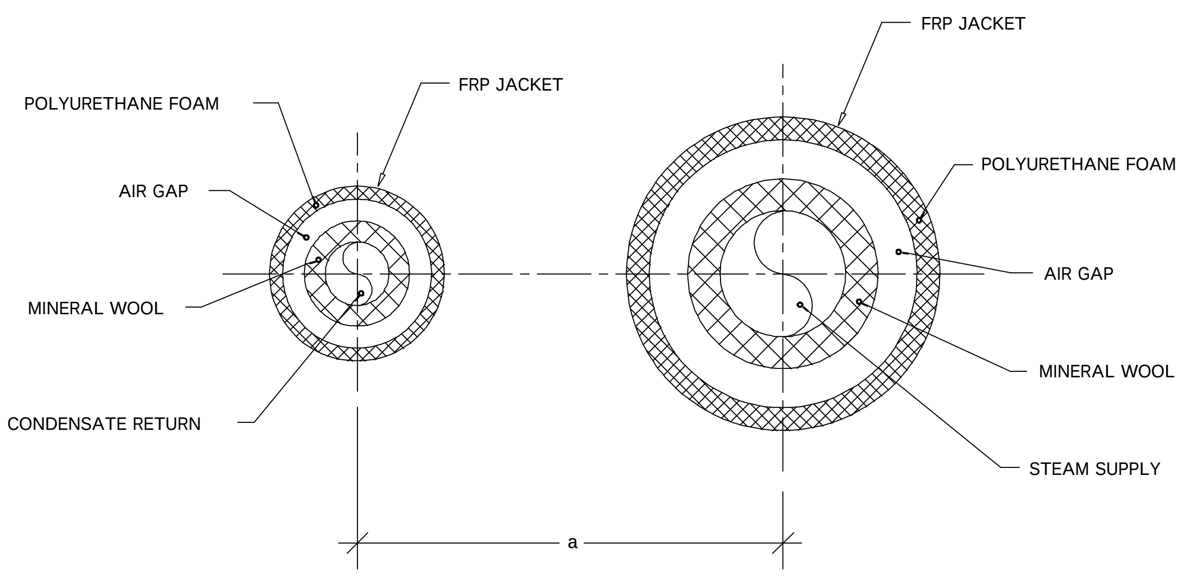


NOTES:

1. SPECIFYING ENGINEER TO INDICATE DIMENSIONS a, b, c.

M-11	DIRT LEG AND STEAM TRAP DETAIL	NTS

(back to text)

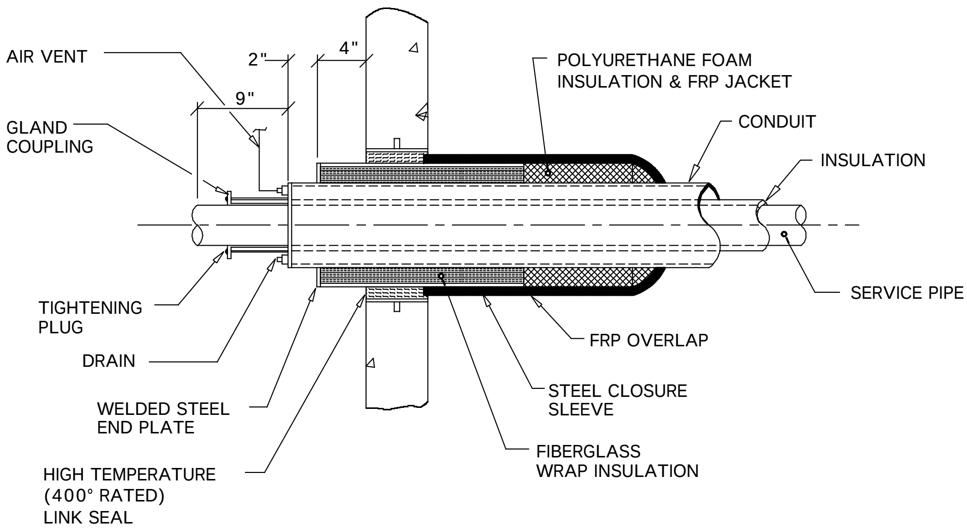


NOTES:

1. SPECIFYING ENGINEER TO INDICATE ADEQUATE DISTANCE a.

M-12	CROSS SECTION OF STEAM SUPPLY AND CONDENSATE RRETURN	NTS

(back to text)

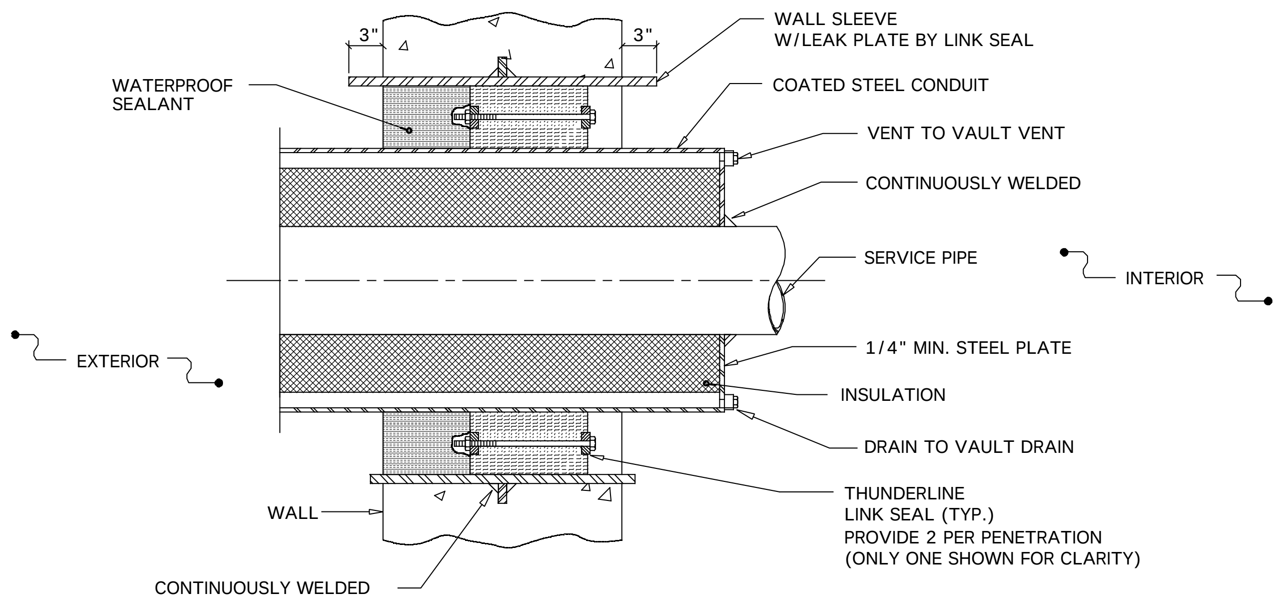


NOTES:

1. COAT ALL METALLIC PORTIONS OF THE END SEAL & STEEL CLOSURE SLEEVE WITH PAINT PROTECTIVE COATING.

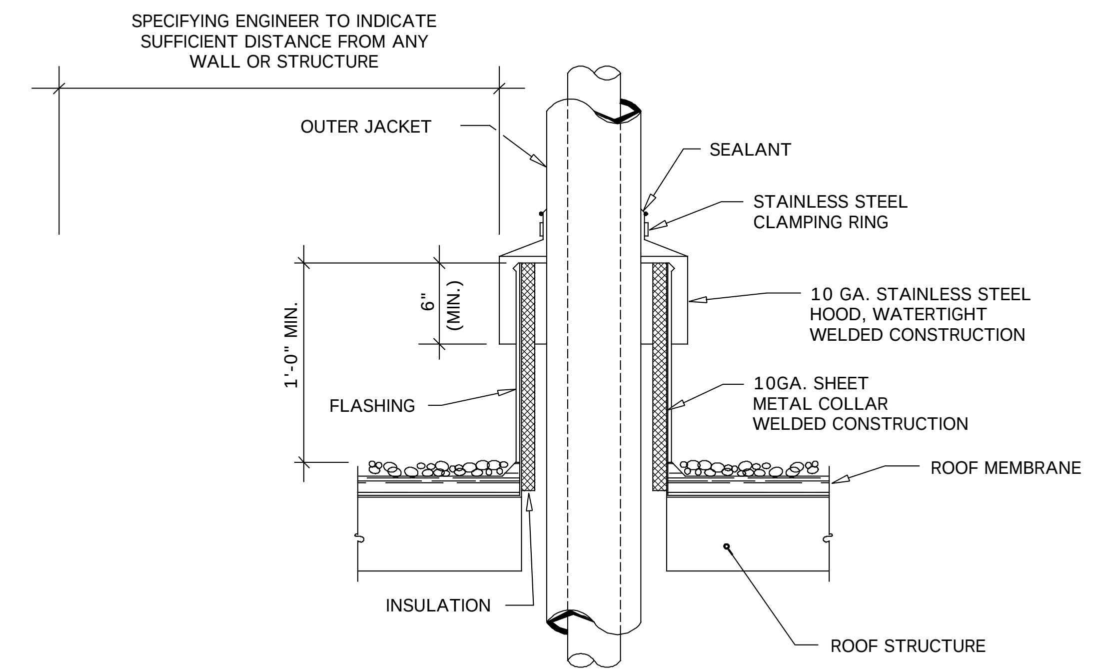
M-13	GLAND SEAL ASSEMBLY	NTS

(back to text)



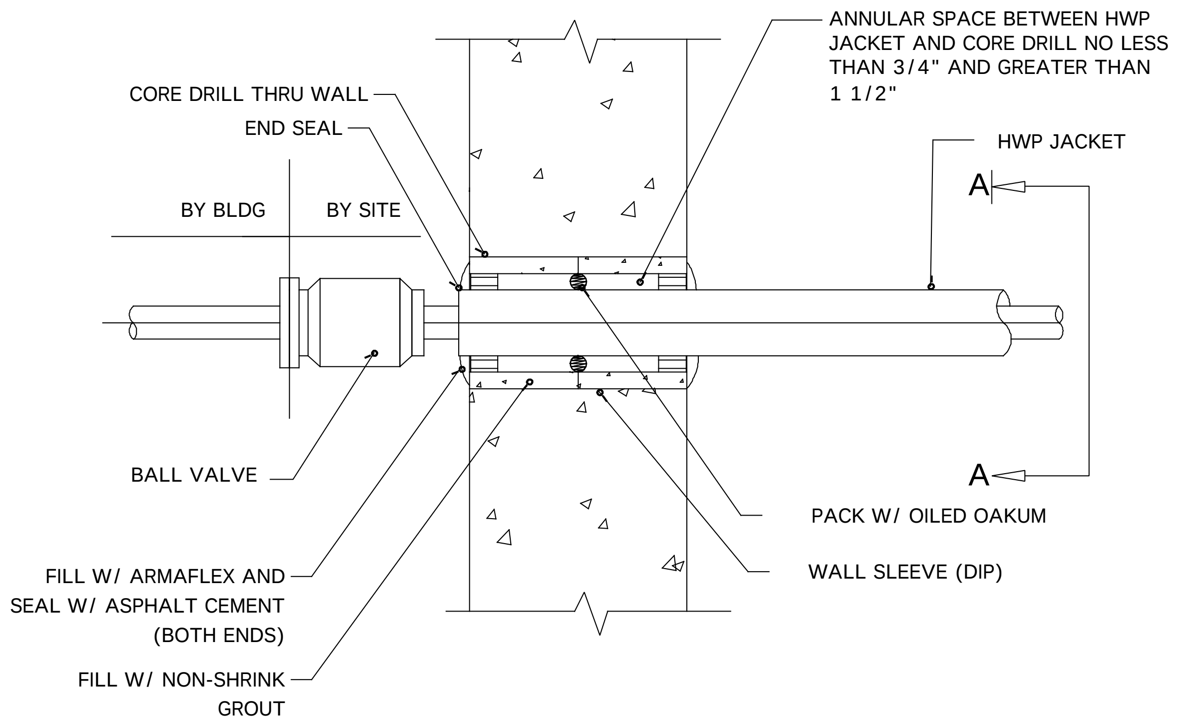
M-14	WALL PENETRATION DETAIL FOR UNDERGROUND STEAM AND CR CONDUIT PIPE	NTS

(back to text)

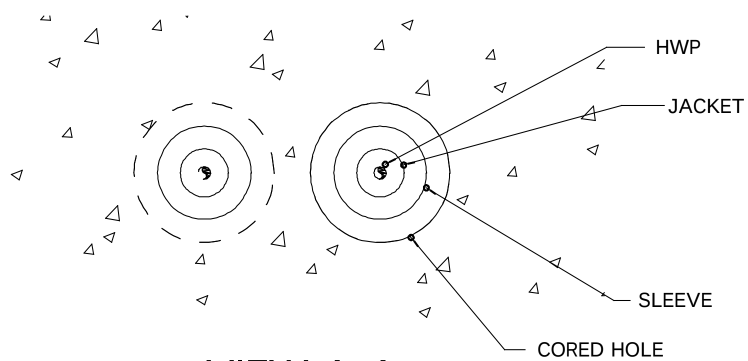


M-15	HOT PIPE PENETRATION DETAIL	NTS

(back to text)



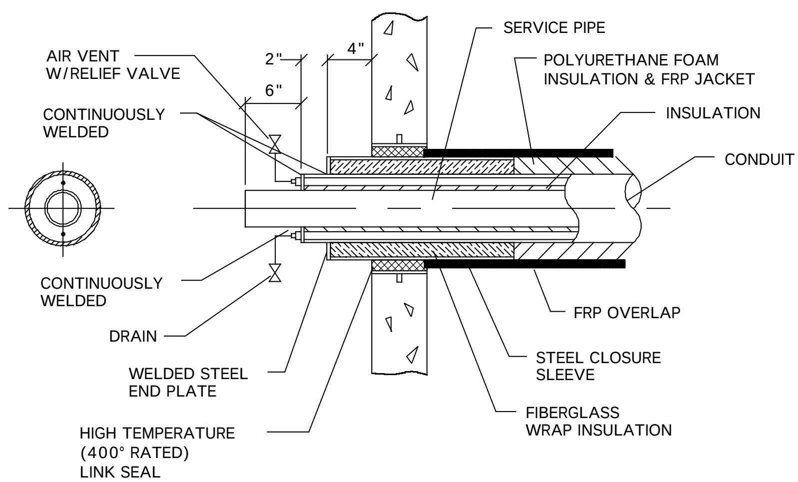
WALL/ FLOOR SECTION



VIEW A-A

M-16	HOT WATER FOUNDATION WALL PENETRATION DETAIL	NTS

(back to text)



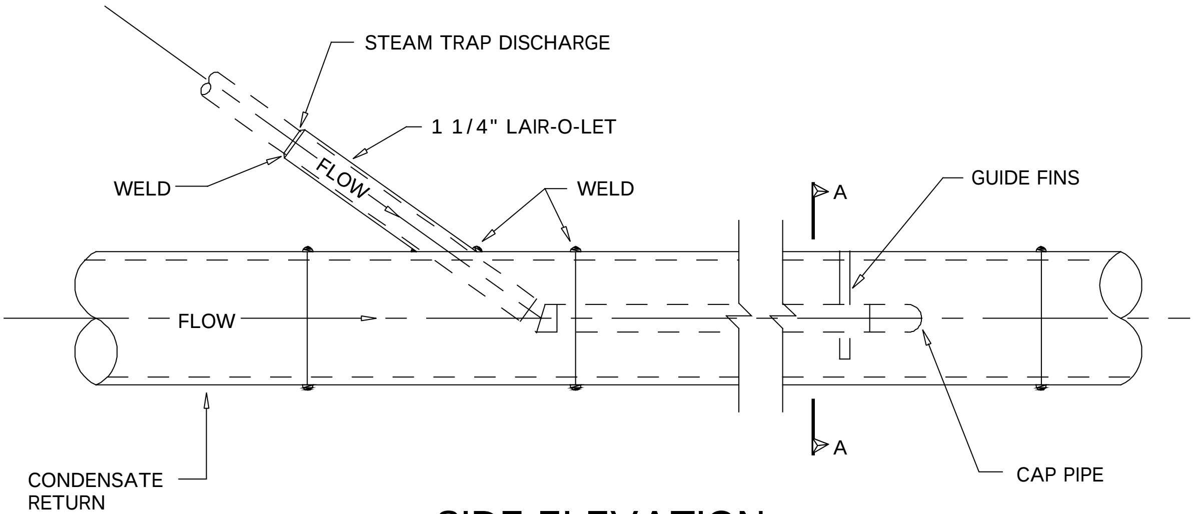
NOTES:

1. COAT ALL METALLIC PORTIONS OF THE END SEAL & STEEL CLOSURE SLEEVE WITH PAINT PROTECTIVE COATING.

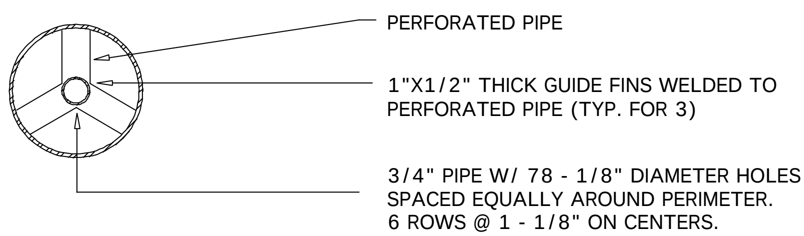
M-17	CONDENSATE END SEAL ASSEMBLY	NTS

(back to text)

NOTE: PROVIDE A 6" SECTION OF FLEXIBLE BRAIDED METAL HOSE, SUITABLE FOR THE SYSTEM OPERATING PRESSURE AND TEMPERATURE, DIRECTLY BEFORE THE PIPING CONNECTION AT THE FLASH ARESSTOR.



SIDE ELEVATION

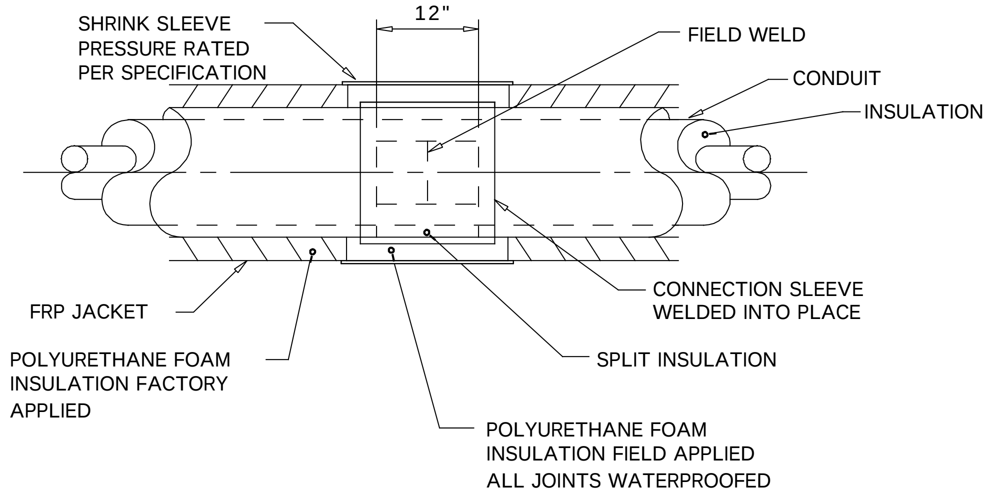


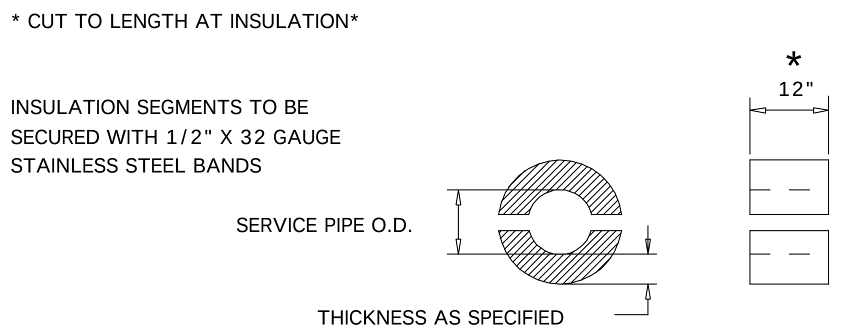
SECTION 'A'

M-18	STEAM TRAP DISCHARGE FLASH ARRESTOR	

NTS

(back to text)



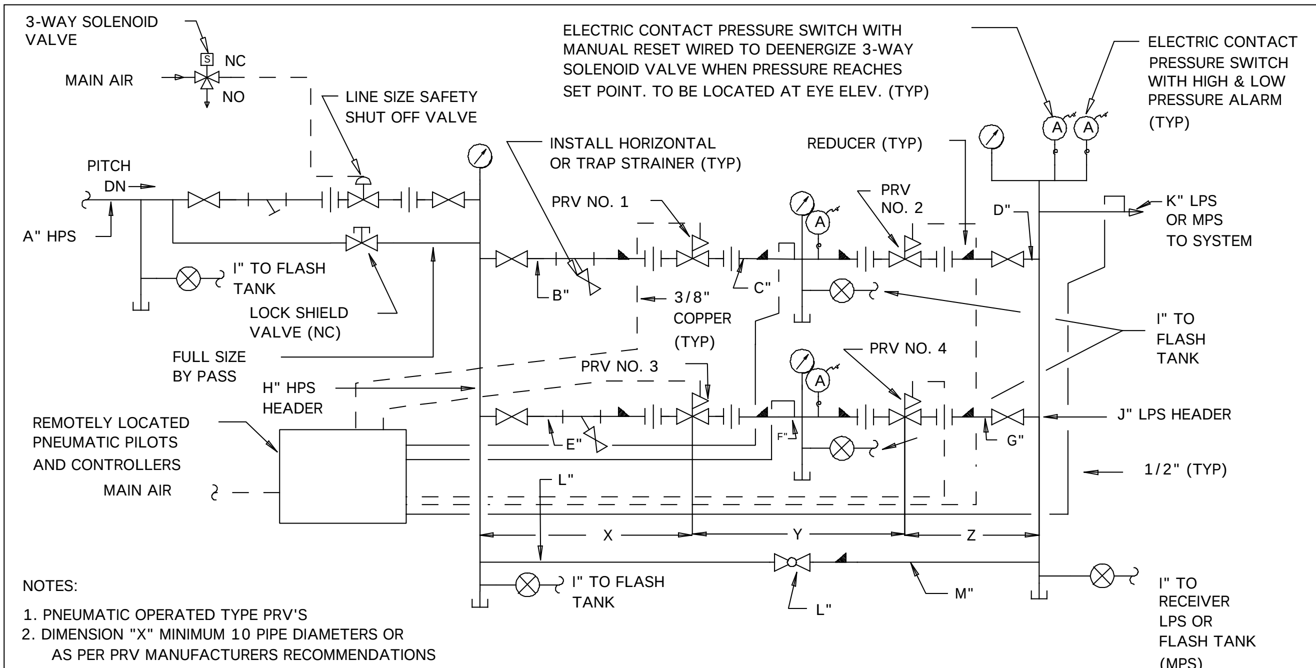


SPLIT INSULATION

STEEL CONNECTION SLEEVE

M-19	FIELD CLOSURE KIT ASSEMBLY	NTS

(back to text)



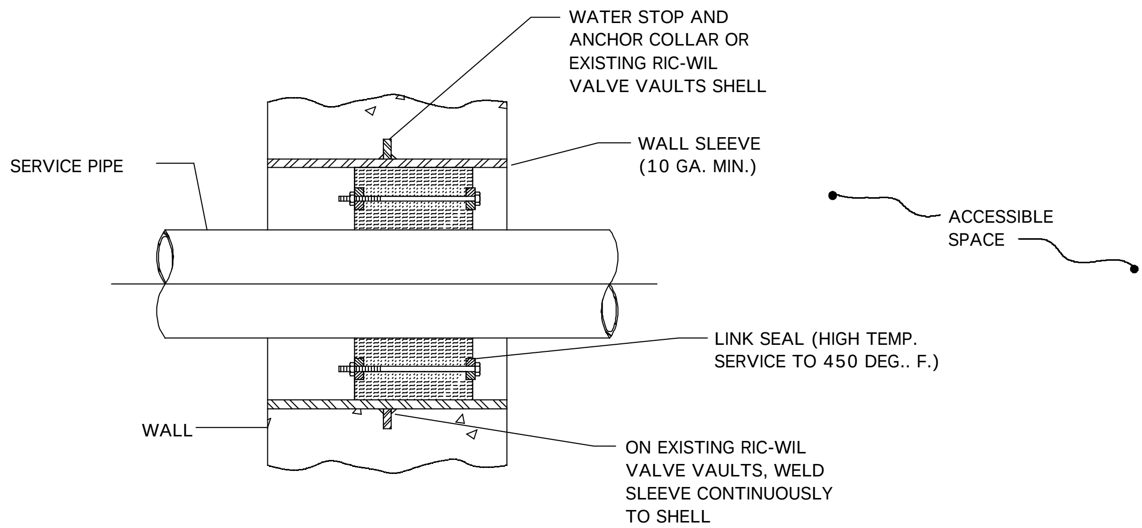
NOTES:

1. PNEUMATIC OPERATED TYPE PRV'S
2. DIMENSION "X" MINIMUM 10 PIPE DIAMETERS OR AS PER PRV MANUFACTURERS RECOMMENDATIONS
3. DIMENSION "Y" MINIMUM 20 PIPE DIAMETERS OR AS PER PRV MANUFACTURERS RECOMMENDATIONS
4. DIMENSION "Z" MINIMUM 20 PIPE DIAMETERS OR AS PER PRV MANUFACTURERS RECOMMENDATIONS
5. SEE PRV STATION SCHEDULE FOR PRV SIZES AND CAPACITIES.
6. PROVIDE SOUND DIFFRACTORS OR SILENCERS AS RECOMMENDED BY PRV MANUFACTURER AS REQUIRED
7. PROVIDE THERMODYNAMIC TRAPS FOR MEDIUM AND HIGH PRESSURE SIDE AND F & T TRAPS FOR LOW PRESSURE SIDE.

PIPE SIZE SCHEDULE (INCHES)

PRV STATION NO	A	B	C	D	E	F	G	H	I	J	K	L	M

M-20	TWO STAGE PARALLEL STEAM PRV STATION WITH SAFETY SHUT-OFF VALVE (PNEUMATIC)	NTS



M-21	WALL PENETRATION DETAIL FOR UNDERGROUND CHILLED WATER SINGLE WALL PIPE	NTS

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VARIABLE SPRING SUPPORT LOAD TABLE										
HANGER NUMBER	GRINNELL FIGURE NUMBER	NODE NUMBER	SIZE	VERTICAL MOVEMENT	HOT LOAD	THEORETICAL INSTALLED LOAD	ACTUAL INSTALLED LOAD	SPRING RATE	HORIZONTAL MOVEMENT	SEE DETAIL
XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
PROVIDE TAG NO. AS SHOWN ON PLANS	*PROVIDE MANUFACTURER MODEL/ FIG. NO.*	*PROVIDE STRESS ANALYSIS NODE NUMBER*		*PROVIDE VERTICAL MOVEMENT OF PIPE*	*PROVIDE OPERATING LOAD OF PIPE*		PROVIDE COLD OR NON OPERATIN GLOAD	PROVIDE DESIGN SPRING RATE	PROVIDE HORIZONTAL MOVEMENT BETWEEN OPERATING AND NON OPERATING CONDITIONS	PROVIDE DETAIL OF SUPPORT AND IDENTIFICATION NUMBER FOR DETAIL

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PIPE SUPPORT LOAD TABLE

DRAWING HANGER NUMBER	STRESS ANALYSIS NODE NUMBER	FORCES IN THE X DIRECTION	FORCES IN THE Y DIRECTION	FORCES IN THE Z DIRECTION	MOMENTS IN THE X DIRECTION	MOMENTS IN THE Y DIRECTION	MOMENTS IN THE Z DIRECTION	SUPPORT DETAIL	REMARKS
xx	xx	xx	xx	xx	xx	xx	xx	xx	-

- PROVIDE TAG NO. AS SHOWN ON PLANS
- PROVIDE STRESS ANALYSIS NODE NUMBER
- PROVIDE FORCES IN THE X DIRECTION FOR THE OPERATING CONDITIONS
- PROVIDE FORCES IN THE Y DIRECTION FOR THE OPERATING CONDITIONS
- PROVIDE FORCES IN THE Z DIRECTION FOR THE OPERATING CONDITIONS
- PROVIDE MOMENTS IN THE X DIRECTION FOR THE OPERATING CONDITIONS
- PROVIDE MOMENTS IN THE Y DIRECTION FOR THE OPERATING CONDITIONS
- PROVIDE MOMENTS IN THE Z DIRECTION FOR THE OPERATING CONDITIONS
- PROVIDE DETAIL OF SUPPORT AND IDENTIFICATION NUMBER FOR DETAIL

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Products

TABLE 1
PIPING INDEX

SYMBOL	SERVICE	OPERATING CONDITION PRESSURE (PSIG)	TEMP. (F)	DESIGN CONDITIONS PRESSURE (PSIG)	TEMP. (F)	PIPE CLASS	PRIMARY ANSI CLASS	TEST PRESSURE (PSIG)	TEST MEDIUM
	STEAM SERVICE								
HPS	High Pressure Steam	300	425	300	450	300	300	450	Water
MPS	Medium Pressure Steam	150	425	150	500	150	150	225	Water
LPS	Low Pressure Steam	12	353	15	353	150L	150	23	Water
	CONDENSATE DRAIN SERVICE								
HPC	High Pressure Condensate Return	200	200	300	450	300C	300	450	Water
MPC	Medium Pressure Condensate Return	40	200	100	425	150C	150	150	Water
LPC	Low Pressure Condensate Return	15	250	15	353	125C	150	25	Water
PC	Pumped Condensate (above ground)	60	200	100	250	150C	150	150	Water
PC	Pumped Condensate (direct buried)	60	200	100	250	150V	150	150	Water
SYMBOL	SERVICE	OPERATING CONDITION PRESSURE (PSIG)	TEMP. (F)	DESIGN CONDITIONS PRESSURE (PSIG)	TEMP. (F)	PIPE CLASS	PRIMARY ANSI CLASS	TEST PRESSURE (PSIG)	TEST MEDIUM
	GAS SERVICE								
CA	Compressed Air	175	150	175	150	125WA	125	263	Air
NG	Natural Gas					150G			Air
	WATER SERVICE								
CHWR	Chilled Water Return	100	54	175	150	125WA	150	263	Water
CHWS	Chilled Water Supply	100	42	175	150	125WA	150	263	Water
HWR	Heating Water Return (Building)	165	160	200	200	125WA	150	300	Water
HWS	Heating Water Supply (Building)	180	180	200	200	125WA	150	300	Water
NPW	Non Potable Water	65	60	100	100	100CU	150	150	Water
SHWR	Heating Water Return (Site Distribution)	50	190	150	250	150WA	150	225	Water
SHWS	Heating Water Supply (Site Distribution)	60	230	150	250	150WA	150	225	Water
W	**A Domestic Water**						350	150	Water
FP	**B Fire Protection**						350	225	Water
	STORMWATER								
SD	**C Storm Drain**								
	SANITARY SEWER								
SS	**D Sanitary Sewer**							4	Air
SYMBOL	SERVICE	OPERATING CONDITIONS PRESSURE (PSIG)	TEMP. (F)	DESIGN CONDITIONS PRESSURE (PSIG)	TEMP. (F)	PIPE CLASS	PRIMARY ANSI CLASS	TEST PRESSURE (PSIG)	TEST MEDIUM
	OIL SERVICE								
FO	Fuel Oil	150	200	240	500	150F	150	360	Air

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Pipe Class:	100 CU						**Material:**	Copper		
Primary ANSI Class:	125						**Primary Material Use:**			
Service Limits	Temperature, °F	150	200	250	300	350	406		Corrosion Allowance 0.05 inch	
	Pressure, psig	200	185	170	155	140	125			

PIPE AND FITTINGS

ITEM	SIZE	THICKNESS	STANDARD	MATERIAL SPECIFICATION[1]
Pipe	6" – Under	Type L above ground, K below		Seamless Hard Copper Tubing ASTM B-88
Unions	1/2" – 2"	-	ANSI B16.22	Bronze, 150# Soldered type
	2 1/2" – 6"	-		Bronze, Use flanges where possible
Flanges	6" and Under	-	ANSI B16.15	Cast Bronze, 125#, ASTM B62, solder joint
Soldered Fittings	1/2" – 6"	-	ANSI B16.18	Soldered type, wrought copper brass or cast bronze, ASTM B75 or B62
Joints	1/2" – 6" Above ground	-	ANSI B16.18	95-5, tin-antimony, solder (lead free for potable service)
	1/2" – 6" Under ground	-		45% Silver solder, 1100°F minimum melting point

VALVES

TYPE	USE	SIZE	STANDARD	SPECIFICATION
Ball	Block/Isolation	1/2" – 2"	ASTM B62	Bronze ASTM B-62, 125# WSP rating, Solder joint, (Hammond 8311, Apollo 7-200 or equal)
Gate	Block/Isolation	2 1/2" and Larger	MSS-SP67 ANSI B16.10	Cast iron body, 125#, ASTM A-126 CL. B, O.S.&Y. solid wedge rising stem with bronze trim and bolted bonnet
Plug	Block / Isolation	1/2" – 2"	MSS-SP80-2 ANSI 16.18	Bronze ASTM B-62, 125# WSP rating, with renewable or regrindable seat, Solder joint
		2 1/2" and Larger	MSS-SP70-1 ANSI B16.10	Cast Iron A-126 , 125#, flanged ends, with renewable or regrindable seat
Disk Globe	Block / Isolation	1/2" – 2"	MSS-SP80-2 ANSI 16.18	Bronze ASTM B-62, 125# WSP rating, with renewable or regrindable seat, Solder joint
		2 1/2" and Larger	MSS-SP70-1 ANSI B16.10	Cast Iron A-126 , 125#, flanged ends, with renewable or regrindable seat
Check/ Swing Type	Prevent Reverse Flow	1/2" – 2"	MSS-SP80-2 ANSI 16.18	Bronze ASTM B-62, 125# WSP rating, Solder joint
		2 1/2" and Larger	MSS-SP70-1 ANSI B16.10	Cast Iron A-126 , 125#, flanged ends, swing or piston check
Check/ Silent Type	Pump Discharge	1/2" – 2"		Spring loaded, Center guided, Manufactured by Williams-Hager, Miller, Mueller, or Combination Pump Valve
		2 1/2" and Larger		Spring loaded, Center guided, Manufactured by Williams-Hager, Miller, Mueller, or Combination Pump Valve

BOLTING AND GASKETS

Bolting:	Studs: Square or hex head, ASTM A-307, Grade B, 2A threads	Nuts: Heavy hex, ANSI B18, 2B threads, ASTM A-194 or A-307	
Gaskets:	1/16" Red rubber, Full face		

NOTE(S):

1. All welds shall comply with requirements of B31.9.
2. All solder joints other than compressed air shall be made 95-5 tin-antimony (lead free).

Back to PIPING INDEX

Pipe Class:	125					**Material:**	Steel				
Primary ANSI Class:	125					**Primary Material Use:**	1.1				
Service Limits	Temperature, °F	100	200	300							Corrosion Allowance 0.05 inch
	Pressure, psig	285	260	230							

PIPE AND FITTINGS

ITEM	SIZE1/2"	THICKNESS	STANDARD	MATERIAL SPECIFICATION[1]
Pipe	1/2" – 2"	Schedule 80	ANSI B36.10	Steel pipe, ASTM A-53 Gr B Seamless or ERW A 106 GR A, B
	2 1/2" and Larger	Schedule 40		Steel pipe, ASTM A-53 Seamless or ERW A 106 GR A, B
Flanges	1/2" – 2"	Bore to Match Pipe	ANSI B16.5	Socket weld or screwed 150#, ASTM A181, Gr. II or A105 Gr II, FF
	2 1/2"" and Larger			Weld neck or slip on 150#, ASTM A181, Gr. II, or A105 Gr II, FF
Fittings	1/2" – 2"	Wall thickness to match pipe	ANSI B16.9	Screwed, 250#, Cast Iron, ASTM A126, Class B
	2 1/2" and Larger	Wall thickness to match pipe	ANSI B16.22	Buttwelded extra strong, ASTM A234, WPA

VALVES

TYPE	USE	SIZE	STANDARD	SPECIFICATION
Gate	Block / Isolation	1/2" – 2"		Crane No. 431UB, 150#, bronze, screwed, ASTM B62
		2 1/2" and Larger	ANSI B16.34	Crane No. 47 1/2, Cast Steel, 150#, butt weld ends, stainless steel trim, bolted bonnet, O.S. & Y., ASTM A216, Gr. WCB
Check/ Swing Type	Prevent Reverse Flow	1/2" – 2"	ANSI B16.10	Crane No. 37, 150#, bronze, screwed, ASTM B62
		2-1/2" and Larger	ANSI 16.34	Crane No. 147 1/2 Cast Steel, 150#, butt weld ends, stainless steel trim, bolted bonnet, O.S. & Y., ASTM A216, Gr. WCB
Globe	Block/Isolation	1/2" – 2" 2 1/2" and Large		Crane No. 7TF, 150#, bronze, screwed, ASTM B62 Crane No. 143 1/2, Cast Steel, 150#, butt weld ends, stainless steel trim, bolted bonnet, O.S. & Y., ASTM A216, Gr. WCB

BOLTING AND GASKETS

Bolting	Studs: Square or Hex head, ASTM A-307, Gr.B, 2A threads	Nuts: Heavy Hex, ASTM A-194 or A-307, ANSI B18, 2B threads	
Gaskets	1/16" Anchor Packing 443A, Flexitallic, 150# for steel to steel, full face for flat flange		

NOTE(S): 1. All welds shall comply with requirements of B31.1.

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Pipe Class: 125C	Material: Steel
Primary ANSI Class: 125	Primary Material Use: 1.1

Service Limits	Temperature, °F	150	200	250	300	350	406		Corrosion Allowance 0.05 inch
	Pressure, psig	200	185	170	155	140	125		

PIPE AND FITTINGS

ITEM	SIZE	THICKNESS	STANDARD	MATERIAL SPECIFICATION[1]
Pipe	1/2" – 2"	Schedule 120	ANSI B36.10	Black steel pipe, ASTM A-53 Gr. B, A-106 Gr. A,B, Seamless or ERW
	2 1/2" and Larger	Schedule 120		Black steel pipe, ASTM A-53 Gr. B, A-106 Gr. A,B, Seamless or ERW
Flanges	1/2" – 2"	Bore to Match Pipe	ANSI B16.5	Steel, 150#, Flat faced, Socket welded or screwed, ASTM A-181, Gr.II or ASTM A-105 Gr.II
	2 1/2" and Larger			Steel, 150#, Flat faced, Weld neck or Slip-on, ASTM A-181, Gr. II or ASTM A-105 Gr.II
Unions	1/2" – 2"			Malleable Iron, 300#, ASTM A-197, Screwed, for ground joint use flanges
	2 1/2" and Larger			Same as above, but seldom used
Fittings	1/2" – 2"	Wall thickness to match pipe	ANSI B16.4	Cast Iron, 250#, ASTM A126, Screwed
	2 1/2" and Larger	Wall thickness to match pipe	ANSI B16.22	Steel, Extra Strong, Butt welded, ASTM A-234, WPA

VALVES

TYPE	USE	SIZE	STANDARD	SPECIFICATION
Ball	Block/Isolation	1/2" – 2"	ANSI B2.1	Class 150, Screwed ASTM B62 (Hammond 8311, Apollo 70-200 or equal)
Gate	Block/Isolation	2 1/2" –8"	ANSI B16.34	Cast iron, 125#, Flanged, Bronze trim, Bolted bonnet, Cast steel solid wedge gate, (Crane No. 473 or equal), ASTM A-126 Class B
	Block/Isolation	10" and Larger		Cast iron, 125#, Flanged, Bronze trim, Bolted bonnet, Cast steel solid wedge gate, (Crane No. 465 _ or equal), ASTM A-126 Class B
Check/ Swing Type	Prevent Reverse Flow	2-1/2" and Larger	ANSI B16.10 MSS SP-70	Cast iron, 125#, Flanged, (Crane No. 373 or equal)
Globe	Block/Isolation	2 1/2" and Large	ANSI B16.34	Cast iron, 125#, Flanged, (Crane No. 351 or equal)

BOLTING AND GASKETS

Bolting	Studs: Square or Hex head, ASTM A-307, Gr. B, 2A threads	Nuts: Heavy Hex, ASTM A-194 or A-307, ANSI B18, 2B threads	
Gaskets	1/16" Anchor Packing 443A, Flexitallic, Remanite, or Garlock Blueguard, 150# ring for steel to steel, full face for flat flange		

NOTE(S):

1. All welds shall comply with requirements of B31.1.
2. All solder joints other than compressed air shall be made 95-5 tin-antimony; compressed air and instrument air tubing shall be made with 45% silver bearing alloy.

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Pipe Class: 125WA For above ground service only	**Material:**
Primary ANSI Class:	**Primary Material Use:**

Service Limits	Temperature, °F	150	200	250	300	350	406		Corrosion Allowance 0.05 inch
	Pressure, psig	200	185	170	155	140	125		

PIPE AND FITTINGS

ITEM	SIZE	THICKNESS	STANDARD	MATERIAL SPECIFICATION[1]
Pipe	1/2" – 2"	Schedule 80	ANSI B36.10	Black steel pipe, ASTM A-53 Gr. B, Seamless or ERW
	2 1/2" and Larger	Standard Wall		Black steel pipe, ASTM A-53 Gr. B, Seamless CW or ERW
Flanges	1/2" – 2"	Bore to Match Pipe	ANSI B16.5	Steel, 150#, Welded or Socket screwed, ASTM A-181, Gr.I or A-105, Gr.I, RF
	2 1/2" and Larger			Steel, 150#, Welded or Slip-on, ASTM A-181, Gr.II or A-105, Gr.II, RF
Fittings (alt.)	2 1/2" and Larger			Grooved ductile iron, ASTM A-536
Couplings (alt.)	2 1/2" and Larger			Victaulic style 77 or 07 as applicable; In lieu of style 07 rigid couplings, Victaulic series 77 flexible couplings must be used on pump suction and discharge, and other connections to rotating or vibrating equipment such as cooling towers and chillers.
Unions	1/2" – 2"			Malleable Iron, 250#, ASTM A197, Screwed, for ground joint use flanges
	2 1/2" and Larger			Use flanges
Fittings	1/2" – 2"	Wall thickness to match pipe	ANSI B16.4	Malleable Iron, 250#, ASTM A126, Screwed
	2 1/2" and Larger		ANSI B16.22	Steel, Extra Strong, Butt welded, ASTM A-234, WPA

VALVES

TYPE	USE	SIZE	STANDARD	SPECIFICATION
Ball	Block/Isolation	1/2" – 2"	ANSI B2.1	Bronze, 125# WSP, Screwed ASTM B62 (Hammond 8311, Apollo 70-200 or equal)
Gate	Block/Isolation	2 1/2" and Larger	ANSI B16.34	Cast iron, 125#, Flanged, ASTM A-126 Class B, Bronze trim, Bolted bonnet, O.S.&Y. solid wedge
Check/ Swing Type	Prevent Reverse Flow	1/2" – 2"	ANSI B16.10	Bronze, 125# WSP, Screwed ASTM B62
		2 1/2" and Larger	ANSI B16.10	Cast iron, 125#, Flanged, ASTM A-126 Class B, Renewable seat, Swing or piston type
Check/ Silent Type	Pump Discharge	1/2" – 2"		Spring loaded, Center guided, Manufactured by Williams-Hager, Miller, Mueller, Victaulic, or Combination Pump Valve, Bronze ASTM B62, 125# screwed ends
		2 1/2" and Larger		Spring loaded, Center guided, Manufactured by Williams-Hager, Miller, Mueller, Victaulic, or Combination Pump Valve, Cast iron ASTM A126 CL B flanged ends
Globe	Block/Isolation	1/2" – 2"	ANSI B16.34	Bronze, 125# WSP, Screwed ASTM B62, Plug disk globe with renewable or regrindable seat
	Block/Isolation	2 1/2" and Large		Cast iron, 125#, Flanged, ASTM A-126 Class B, plug disc globe
Butterfly	Block/Isolation	2 1/2" and Large		Use for main line valves. Provide valves designed for bubble tight shut-off at 200 psig. differential pressure with water at 150°F. For installations between flanges, provide lug type or flanged valves. Provide steel body, worm gear operated, SS shaft, bronze or Ni-Resist disc, and Buna-N seat. Centerline Series A (designed for use w/ 150# standard flange), DeZurik High Pressure Series (designed for use w/ 150# or 300# standard flanges) or equal from Fisher Controls. Also, Pratt Model 2F II flanged, 0107 AWWA approved or Crane #27 flanged AWWA approved. For grooved end application use Victaulic 300 (2"-12") or 709 (14"-24"). For butterfly valves 4" and larger, specify the valve manufacturer's gear operator.

BOLTING AND GASKETS

Bolting	Studs: Square or Hex head, ASTM A-307, Gr. B, 2A threads	Nuts: Heavy Hex, ASTM A-194 or A-307, ANSI B18, 2B threads	
Gaskets	1/16" Red Rubber or EPDM for grooved fittings; Ring for raised face joints, full face for flat flanges		

NOTE(S):
1. All welds shall comply with requirements of B31.1.
2. All solder joints other than compressed air shall be made 95-5 tin-antimony; compressed air and instrument air tubing shall be made with 45% silver bearing alloy.

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Pipe Class:	150	**Material:**	Carbon Steel
Primary ANSI Class:	150	**Primary Material Use:**	1.1

Service Limits	Temperature, °F	100	200	300	400	500	600	700		Corrosion Allowance 0.05 inch
	Pressure, psig	285	260	230	200	170	140	110		

PIPE AND FITTINGS

ITEM	SIZE	THICKNESS	STANDARD	MATERIAL SPECIFICATION[1]
Pipe	1/2" – 2"	Schedule 80	ANSI B36.10	Seamless ASTM A-53 Gr. A & B, ASTM A-106 Gr. A & B
	2 1/2" and Larger	Schedule 40 or standard wall		Seamless ASTM A-53 Gr. A & B, ASTM A-106 Gr. A & B
Flanges	1/2" – 2"	Bore to Match Pipe	ANSI B16.5	Steel 150#, ASTM A-181, Gr. I, Socket welded, RF
	2 1/2" and Larger			Steel 150#, ASTM A-181, Gr. I, Weld neck, RF
Fittings	1/2" – 2"	3000#	ANSI B16.11	Socket welded ASTM A-105 Gr. II
	2 1/2" and Larger	Standard	ANSI B16.9	Steel, Standard, Butt welded ASTM A-234 WPA
Unions	1/2"" – 2"	3000#	ANSI B16.11	Socket welded ASTM A-105 Gr. II, Forge Steel ground joint

VALVES

TYPE	USE	SIZE	STANDARD	SPECIFICATION
Gate	Block / Isolation	1/2"" – 2"	ANSI B16.34	Forged carbon steel ASTM A-105 Gr. II, Class 800, bolted bonnet, OS&Y, Stainless Steel trim, socket welded ends
		2-1/2" and Larger		Carbon steel ASTM A-216 Gr. WCB, 150# ANSI rating, Butt welded ends or flanged, Stainless steel trim, bolted bonnet, OS&Y
Globe	Throttling	/2" – 2"	ANSI B16.34	Forged carbon steel ASTM A-105 Gr. II, Class 800, bolted bonnet, OS&Y, Stainless Steel trim, socket welded ends
		2-1/2" and Larger		Carbon steel ASTM A-216 Gr. WCB, 150# ANSI rating, Butt welded ends or flanged, Stainless steel trim, bolted bonnet
Check/ Swing Type	Prevent Reverse Flow	1/2" – 2"	ANSI B16.34	Forged carbon steel ASTM A-105 Gr. II, Class 800, bolted bonnet, OS&Y, Stainless Steel trim, socket welded ends, Swing or piston
		2-1/2" and Larger		Carbon steel ASTM A-216 Gr. WCB, 150# ANSI rating, Butt welded ends or flanged, Stainless steel trim, bolted bonnet

BOLTING AND GASKETS

Bolting	Studs: Square or Hex Head, ASTM A-193, 2A threads	Nuts: Heavy Hex ASTM A-194, ANSI B18 2B threads	
Gaskets	1/16" thick Anchor Packing 443A, Flexitallic, Remanite, or Garlock Blueguard. 150# ring for steel to steel, full face for flat flanges.		

NOTE(S): 1. All welds shall comply with requirements of B31.1.

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Pipe Class:	150C	**Material:**	Carbon Steel
Primary ANSI Class:	150	**Primary Material Use:**	1.1

Service Limits									Corrosion Allowance
	Temperature, °F	100	200	300	400	500	600	700	0.05 inch
	Pressure, psig	285	260	230	200	170	140	110	

PIPE AND FITTINGS

ITEM	SIZE	THICKNESS	STANDARD	MATERIAL SPECIFICATION[1]
Pipe	1/2"" – 3"	Schedule XXS	ANSI B36.10	Seamless ASTM A-106 Gr. B
	4" and Larger	Schedule 120		Seamless ASTM A-53 Gr. B
Flanges	1/2" – 2"	Bore to Match Pipe	ANSI B16.5	Socket welded 150#, ASTM A-181, Gr. I, RF
	2 1/2" and Larger			Weld neck 150#, ASTM A-181, Gr. I, RF
Fittings	1/2" – 2"	3000#	ANSI B16.11	Socket welded forged CS steel ASTM A-105 Gr. II
	2 1/2" and Larger	Standard	ANSI B16.9	Butt weld seamless ASTM A-234 WPA

VALVES

TYPE	USE	SIZE	STANDARD	SPECIFICATION
Gate	Block / Isolation	1/2" – 2"		Forged carbon steel ASTM A-105 Gr. II, Class 800, bolted bonnet, OS&Y, Stainless Steel trip, socket welded ends
		2-1/2" – 16"	ANSI B16.34	Carbon steel ASTM A-216 Gr. WCB, 150# ANSI rating, Butt welded ends or flanged, Stainless steel trim, bolted bonnet, OS&Y
Globe	Throttling	1/2" – 2"		Forged carbon steel ASTM A-105 Gr. II, Class 800, bolted bonnet, OS&Y, Stainless Steel trip, socket welded ends
		2-1/2" – 16"	ANSI B16.34	Carbon steel ASTM A-216 Gr. WCB, 150# ANSI rating, Butt welded ends or flanged, Stainless steel trim, bolted bonnet, OS&Y
Check/ Swing Type	Prevent Reverse Flow	1/2" – 2"		Forged carbon steel ASTM A-105 Gr. II, Class 800, bolted bonnet, OS&Y, Stainless Steel trip, socket welded ends
		2-1/2" – 16"		Carbon steel ASTM A-216 Gr. WCB, 150# ANSI rating, Butt welded ends or flanged, Stainless steel trim, bolted bonnet, OS&Y
Traps		All		300#, steel inverted bucket, Armstrong 310

BOLTING AND GASKETS

Bolting	Studs: ASTM A-193, 2A threads	Hex Nuts: ASTM A-194, 2B threads, heavy hex	Cap Screws: ASTM A-325
Gaskets	1/16" thick, Flexitallic "CG", packing 443A, 150# ring for steel to steel, full face for flat flange		

NOTE(S): 1. All welds shall comply with requirements of B31.1.

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Pipe Class:	150F	**Material:**	Carbon Steel
Primary ANSI Class:	150	**Primary Material Use:**	1.1

Service Limits	Temperature, °F	150	200	250	300	350	406		Corrosion Allowance 0.05 inch
	Pressure, psig	225	210	195	180	165	150		

PIPE AND FITTINGS

ITEM	SIZE	THICKNESS	STANDARD	MATERIAL SPECIFICATION[1]
Pipe	1/2" – 2"	Schedule 80	ANSI B36.10	Seamless ASTM A-53, CW or ERW, ASTM A106
	2 1/2" and Larger	Schedule 40		Seamless ASTM A-53, CW or ERW, ASTM A106
Flanges	2 1/2" and Larger	Bore to Match Pipe	ANSI B16.5	Steel 150#, Weld neck or Slip on, ASTM A-181 Gr. I or A-105 Gr. I, RF
Fittings	2 1/2" and Larger	Wall thickness to match pipe	ANSI B16.9	Steel, Standard, Butt welded, ASTM A-234 WPA
	1/2" – 2"	150#	ANSI B16.11	Malleable Iron, Screwed ASTM A-197
Unions	1/2" – 2"	300#	ANSI B16.11	Malleable Iron, Screwed ASTM A-197

VALVES

TYPE	USE	SIZE	STANDARD	SPECIFICATION
Gate	Block / Isolation	1/2" – 2"		Body, bonnet, disc and stem-bronze ASTM B-62, Screwed, Crane No. 431 UB.
		2-1/2" and Larger	ANSI B16.34	Cast steel ASTM A-216 Gr. WCB, 150# ANSI rating butt-welded ends, SS trim, bolted bonnet, Crane No. 47 1/2.
Globe	Throttling	1/2" – 2"		Body, bonnet, disc and stem-bronze ASTM B-62, Screwed, Crane No. 7TF.
		2-1/2" and Larger	ANSI B16.34	Cast steel ASTM A-216 Gr. WCB, 150# ANSI rating butt welded ends, SS trim, bolted bonnet, Crane No. 143 1/2.
1/2Check/ Swing Type	Prevent Reverse Flow	1/2" – 2"		Body, bonnet, disc and stem-bronze ASTM B-62, Screwed, Crane No. 37.
		2-1/2" and Larger		Cast steel ASTM A-216 Gr. WCB, 150# ANSI rating butt welded ends, SS trim, bolted bonnet, Crane No. 147 1/2.

BOLTING AND GASKETS

Bolting	Studs: ASTM A-307, Square or Hex Head, 2A threads	Nuts: Heavy hex, ASTM A-194, or A-307, ANSI B18, 2B threads	
Gaskets	1/16" thick Anchor Packing 445, Flexitallic, Remanite, or Garlock Blueguard.		

NOTE(S):

1. All welds shall comply with requirements of B31.1.

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Pipe Class:	150G					**Material:**	Carbon Steel		
Primary ANSI Class:	150					**Primary Material Use:**	1.1		
Service Limits	Temperature, °F	150	200	250	300	350	406		Corrosion Allowance 0.05 inch
	Pressure, psig	225	210	195	180	165	150		

PIPE AND FITTINGS

ITEM	SIZE	THICKNESS	STANDARD	MATERIAL SPECIFICATION[1]
Pipe ANSI B36.10	1/2" – 2"	Schedule 80	ANSI B36.10	Seamless ASTM A-53, Grade B, ASTM A106,GrB
	2 1/2" and Larger	Schedule 40		Seamless ASTM A-53, Grade B, ASTM A106,GrB
Flanges ANSI B16.5	2 1/2" and Larger	Bore to Match Pipe	ANSI B16.5	Steel 150#, Weld neck or Slip on, ASTM A-181 Gr. I or A-105 Gr. I
Weld Fittings	2 1/2" and Larger	Wall thickness to match pipe	ANSI B16.9	Steel, Butt welded, ASTM A-234 WPA
Threaded Fittings	1/2" – 2"	150#	ANSI B16.11	Malleable Iron, Banded screwed ASTM A-197
Unions	1/2" – 2"	250#	ANSI B16.11	Malleable Iron, Screwed ground joint ASTM A-197

VALVES

TYPE	USE	SIZE	STANDARD	SPECIFICATION
Gate	Block / Isolation	1/2" – 2"	ANSI B2.1 or B62	Steel A105, Class 150 ANSI B2.1, or Bronze ANSI B62, 200#, Screwed
		2-1/2" – 4"	ANSI B16.34	Cast iron ASTM A-216 Class B, 125# ANSI flanged ends, bolted bonnet, O.S.&Y. solid wedge gate
		5" and Larger	ANSI B16.34	Cast steel ASTM A-216 Gr. WCB, 150# ANSI rating butt welded ends, SS trim, bolted bonnet
Plug	Block / Isolation	2-1/2" – 4"	ANSI B16.34	Cast iron ASTM A-216 Class B, 125# ANSI flanged ends, bolted bonnet.
Globe	Throttling	1/2" – 2"	ANSI B2.1 or B62	Steel A105, Class 150 ANSI B2.1, or Bronze ANSI B62, 200#, Screwed
		2-1/2" – 4"	ANSI B16.34	Cast iron ASTM A-216 Class B, 125# ANSI flanged ends, bolted bonnet disc globe, renewable seat
		5" and Larger	ANSI B16.34	Cast steel ASTM A-216 Gr. WCB, 150# ANSI rating butt welded ends, SS trim, bolted bonnet

BOLTING AND GASKETS

Bolting	Studs: ASTM A-307, Square or Hex Head, 2A threads	Nuts: Heavy hex, ASTM A-194, or A-307, ANSI B18, 2B threads	
Gaskets	1/16" thick Anchor Packing 445, Flexitallic, Remanite, or Garlock Blueguard.		

NOTE(S): 1. All welds shall comply with requirements of B31.1.

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Pipe Class:	150L	**Material:**	Carbon Steel
Primary ANSI Class:	150	**Primary Material Use:**	1.1

Service Limits	Temperature, °F	150	200	250	300	350	406		Corrosion Allowance 0.05 inch
	Pressure, psig	225	210	195	180	165	150		

PIPE AND FITTINGS

ITEM	SIZE	THICKNESS	STANDARD	MATERIAL SPECIFICATION[1]
Pipe	1/2" – 2"	Schedule 80	ANSI B36.10	Seamless ASTM A-53, CW
	2 1/2"" and Larger	Schedule 40 or Standard Wall		Seamless ASTM A-53, CW or ERW
Flanges	1/2" – 2"	Bore to Match Pipe	ANSI B16.5	Steel, 150# RF, Socket welded, ASTM A-181, Gr. I
	2 1/2" and Larger			Steel 150# RF, Weld neck, ASTM A-181, Gr. I
Weld Fittings	2 1/2" nd Larger	Wall thickness to match pipe	ANSI B16.9	Steel, Butt welded, ASTM A-234 WPA
Threaded Fittings	1/2" – 2"	250#	ANSI B16.11	Cast Iron, Screwed ASTM A-126, Class B
Unions	1/2" – 2"	300#	ANSI B16.11	Malleable Iron, Screwed ASTM A-197

VALVES

TYPE	USE	SIZE	STANDARD	SPECIFICATION
Gate	Block / Isolation	1/2" – 2"		Body, bonnet, disc and stem-bronze ASTM B-62, Screwed, Crane No. 431 UB.
		2-1/2" and Larger	ANSI B16.34	Cast steel ASTM A-216 Gr. WCB, 150# ANSI rating butt-welded ends, SS trim, bolted bonnet, Crane No. 47 1/2
Globe	Throttling	1/2" – 2"		Body, bonnet, disc and stem-bronze ASTM B-62, Screwed, Crane No. 7TF.
		2-1/2" and Larger	ANSI B16.34	Cast steel ASTM A-216 Gr. WCB, 150# ANSI rating butt-welded ends, SS trim, bolted bonnet, Crane No. 143 1/2.
Check/ Swing Type	Prevent Reverse Flow	1/2" – 2"		Body, bonnet, disc and stem-bronze ASTM B-62, Screwed, Crane No. 37.
		2-1/2" and Larger		Cast steel ASTM A-216 Gr. WCB, 150# ANSI rating butt-welded ends, SS trim, bolted bonnet, Crane No. 147 1/2.

BOLTING AND GASKETS

Bolting	Studs: ASTM A-193, Square or Hex head, 2A threads.	Nuts: Heavy Hex ASTM A-194, ANSI B18, 2B threads.	
Gaskets	1/16" thick Anchor Packing 443A, Flexitallic, Remanite, or Garlock Blueguard. 150# ring for steel to steel, full face for flat flanges.		

NOTE(S):

1. All welds shall comply with requirements of B31.1.

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Pipe Class: **150WA**	**Material:** Carbon Steel
Primary ANSI Class: 150	**Primary Material Use:** 1.1

Service Limits	Temperature, °F	100	200	300						Corrosion Allowance 0.05 inch
	Pressure, psig	285	260	230						

PIPE AND FITTINGS

ITEM	SIZE	THICKNESS	STANDARD	MATERIAL SPECIFICATION[1]
Pipe	1/2” – 2”	Schedule 80	ANSI B36.10	Seamless ASTM A-106 Gr. B ASTM A53 Gr B
	2 1/2” – 10”	Schedule 40		Seamless ASTM A-106 Gr. B or ASTM A 53 Gr. B
	12” – 16”	Std. (.375”)		Seamless ASTM A 53 Gr. B
Flanges	1/2” – 2”	Bore to Match Pipe	ANSI B16.5	Screwed 150# RF, ASTM A-105, Gr. I or II
	2 1/2” – 16”			Weld neck 150# RF, ASTM A-105, Gr. I or II
Weld Fittings	2 1/2”” – 16”	Wall thickness to match pipe	ANSI B16.9	Butt weld seamless ASTM A-234 WPB
Threaded Fittings	1/2” – 2”	3000#	ANSI B16.11	Screwed forged CS steel ASTM A-105 Gr. II

VALVES

TYPE	USE	SIZE	STANDARD	SPECIFICATION
Ball	Block / Isolation at Building entrance	1/2” – 16”	DIN 3230 & ISO 5208	Body Steel St. 37.0, welded end (site end) St. 37.0 & one flanged end ANSI 150 # (building end), stainless steel ball DIN X 5 – CrNi 189, Carbon reinforced PTFE seats, PTFE/ graphite seals. (Fig. 125.14 PN25 by JiP Kugleventiler A/S)
Ball	Block Isolation between building entrance and heat exchanger. Also on heat exchanger skid	1/2” – 2”	MSS-SP-110	B62, bronze 400 WOG, screwed ends, (Crane Apollo 70-200 or Hammond 8311)
Gate	Block Isolation Between building entrance and heat exchanger	2 1/2” – 16”	ANSI 16.34	Carbon steel ASTM A-216 Gr. WCB, ANSI 150#, butt weld ends, stainless steel trim, bolted bonnet, O.S. & Y. (Crane 47 _)
Bufferfly	Block Isolation On heat exchanger skid	2 1/2” – 16”	MSS-SP-67 & ANSI 16.5	Carbon steel ASTM A-216 Gr. WCB, ANSI 150#, Lug style ends, stainless steel shaft/stem, bronze or Ni-resist disc, gear oper. 4” & up, with EPDM seats rated for 150 psig @ 275 DegF. Bubble tight shut-off to 200 psig. (Crane, Dezurik, & Centerline)

BOLTING AND GASKETS

Bolting	Studs: ASTM A-193, GR B-7	Hex Nuts: ASTM A-194, Class 2H	Cap Screws: ASTM A-325
Gaskets	150# spiral wound, 304 stainless steel, 1/8” thick, Flexitallic “CG”		

NOTE (S):

1. All welds shall comply with requirements of B31.9.
2. This specification for piping between site piping extended through foundation and Hot Water Conversion Heat Exchanger Module (HWCHEM) use building piping and plumbing specifications for building side connections to HWCHEM.
3. Install valve at building entrance with welded end on site side of valve and flange end on building side of valve.
4. Provide gear operators on valves 6” and up. Chain wheels required on valves wheels 72” above F.F.
5. Provide stanchion support under valves at building entrance do not support valve weight from site piping extended through wall.
6. Provide Dielectric insulating flange kit at flange between site piping and building piping on first flange at building entrance. Acceptable manufacturer: Intergy/Ricwill Piping Systems, P.O. Box 939, Boston, and Ma. 02117.
7. Valve manufacturer for building entrance valve – JiP Kugleventiler A/S Rep. (450)-455-0961.

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Pipe Class: 300										**Material:** Carbon Steel
Primary ANSI Class: 300										**Primary Material Use:** 1.1
Service Limits	Temperature, °F	100	200	300	400	500	600	750		Corrosion Allowance 0.05 inch
	Pressure, psig	740	675	655	635	600	550	505		

PIPE AND FITTINGS

ITEM	SIZE	THICKNESS	STANDARD	MATERIAL SPECIFICATION[1]
Pipe	1/2" – 2"	Schedule 80	ANSI B36.10	Seamless ASTM A-53 Gr. B, ASTM A 106, Gr B
	2 1/2" and larger	Schedule 40		Seamless ASTM A-53 Gr. B, ASTM A 106 Gr B
Flanges	1/2" – 2"	Bore to Match Pipe	ANSI B16.5	Socket welded 300# RF, ASTM A-105, Gr. II,
	2 1/2" and larger			Weld neck 300# RF, ASTM A-105, Gr. II
Fittings	1/2" – 2"	3000#	ANSI B16.11	Socket welded forged CS steel; ASTM A-105 Gr. II
Fittings	2 1/2" and Larger		ANSI B16.9	Butt weld seamless ASTM A-234 WPB

VALVES

TYPE	USE	SIZE	STANDARD	SPECIFICATION
Gate	Block / Isolation	1/2" – 2"		Forged carbon steel ASTM A-105, 600 # ANSI rating, bolted bonnet, OS&Y, Stainless steel trim, socket welded ends
		2-1/2" and larger	ANSI B16.34	Carbon steel ASTM A-216 Gr. WCB, 300# ANSI rating, Butt welded ends, OS&Y, Stainless steel trim
Globe	Throttling	1/2" – 2"		Forged carbon steel ASTM A-105, 600 # ANSI rating, bolted bonnet, OS&Y, Stainless steel trim, socket welded ends
		2-1/2" and larger	ANSI B16.34	Carbon steel ASTM A-216 Gr. WCB, 300# ANSI rating, Butt welded ends, OS&Y, Stainless steel trim
Check/ Swing Type	Prevent Reverse Flow	1/2" – 2"	ANSI B16.34	Forged carbon steel ASTM A-105, 600 # ANSI rating, bolted bonnet, OS&Y, Stainless steel trim, socket welded ends
		2-1/2" and larger		Carbon steel ASTM A-216 Gr. WCB, 300# ANSI rating, Butt welded ends, OS&Y, Stainless steel trim
Traps		All		Cast steel or forged steel, 300#, Bucket type

BOLTING AND GASKETS

Bolting	Studs: ASTM A-193, GR B-7, heavy hex	Hex Nuts: ASTM A-194, Class 2H, heavy hex	Cap Screws: ASTM A-325
Gaskets	1/16" Anchor packing 443A,Flexitallic,Remantite, or Garlock Blueguard, 300# for steel on steel, full face for flat flange		

NOTE(S):

1. All welds shall comply with requirements of B31.1.
2. Valve packing for 300 class and 600 class steam service valves with Teflon impregnated packing similar to Chesterton "Superlon style 1724.

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Pipe Class:	300C					**Material:**	Carbon Steel				
Primary ANSI Class:	300					**Primary Material Use:**	1.1				
Service Limits	Temperature, °F	100	200	300	400	500	600	750		Corrosion Allowance 0.05 inch	
	Pressure, psig	740	675	655	635	600	550	505			

PIPE AND FITTINGS

ITEM	SIZE	THICKNESS	STANDARD	MATERIAL SPECIFICATION[1]
Pipe	1/2" – 3"	Schedule XXS	ANSI B36.10	Seamless ASTM A-53 Gr. B, ASTM A106 Gr B
	4" and larger	Schedule 120		Seamless ASTM A-53 Gr. B, ASTM A106 Gr B
Flanges	1/2" – 2"	Bore to Match Pipe	ANSI B16.5	Socket welded 300# RF, ASTM A-105, Gr. II,
	2 1/2" and larger			Weld neck 300# RF, ASTM A-105, Gr. II
Fittings	1/2" – 2"	3000#	ANSI B16.11	Socket welded forged CS steel; ASTM A-105 Gr. II
Fittings	2 1/2" and Larger		ANSI B16.9	Butt weld seamless ASTM A-234 WPB

VALVES

TYPE	USE	SIZE	STANDARD	SPECIFICATION
Gate	Block / Isolation	1/2" – 2"		Forged carbon steel ASTM A-105, 600 # ANSI rating, bolted bonnet, OS&Y, Stainless steel trim, socket welded ends
		2-1/2" and larger	ANSI B16.34	Carbon steel ASTM A-216 Gr. WCB, 300# ANSI rating, Butt welded ends, OS&Y, Stainless steel trim
Globe	Throttling	1/2" – 2"		Forged carbon steel ASTM A-105, 600 # ANSI rating, bolted bonnet, OS&Y, Stainless steel trim, socket welded ends
		2-1/2" and larger	ANSI B16.34	Carbon steel ASTM A-216 Gr. WCB, 300# ANSI rating, Butt welded ends, OS&Y, Stainless steel trim
Check/ Swing Type	Prevent Reverse Flow	1/2" – 2"	ANSI B16.34	Forged carbon steel ASTM A-105, 600 # ANSI rating, bolted bonnet, OS&Y, Stainless steel trim, socket welded ends
		2-1/2" and larger		Carbon steel ASTM A-216 Gr. WCB, 300# ANSI rating, Butt welded ends, OS&Y, Stainless steel trim
Traps		All		Cast steel or forged steel, 300#, Bucket type

BOLTING AND GASKETS

Bolting	Studs: ASTM A-193, GR B-7, heavy hex	Hex Nuts: ASTM A-194, Class 2H, heavy hex	Cap Screws: ASTM A-325
Gaskets	1/16" Anchor packing 443A,Flexitallic,Remantite, or Garlock Blueguard, 300# ring for steel to steel, full face for flat flange		

NOTE(S):

1. All welds shall comply with requirements of B31.1.
2. Valve packing for 300 class and 600 class steam service valves with Teflon impregnated packing similar to Chesterton "Superlon style 1724.

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Pipe Class:	**Material:** Ductile Iron
Primary ANSI Class: 350	**Primary Material Use:**

PIPE AND FITTINGS

ITEM	SIZE	THICK-NESS	STANDARD	MATERIAL SPECIFICATION
Pipe	6" and Larger		ANSI A21.50 AWWA C150/ ANSI A21.51 AWWA C151	Class 52, cement lined, tar coated ductile iron, push on joint
Restraints	6" and Larger			Restraints for push-on joints shall be Series 800 coverall as manufactured by Ebba Iron Co. or equal, restraints for mechanical joint fittings shall be Megalug as manufactured by Ebba Iron Co. or equal
Fittings	6" and Larger		ANSI A21.53 AWWA C153	Compact ductile iron mechanical joint
Tapping Sleeve (**See Detail C-9**)	6" and Larger		AWWA C500	Mechanical joint type, Mueller H-615, American Darling 1004, or equal

VALVES

TYPE	USE	SIZE	STANDARD	SPECIFICATION
Gate	Block/ Isolation	6" – 16"	AWWA C509	Cast iron body, resilient seated, mechanical joint ends, valves shall have a 2-inch standard AWWA operating nut
Butterfly	Block/ Isolation	16" and Larger	AWWA C504	Cast iron ASTM A-126 Class B body, integrally cast mechanical joint ends, Type 304 stainless steel body seat made integral with the valve body. Valve and vanes shall have corrosion resistant, fusion-bonded interior and exterior epoxy coatings. Coatings shall be an average minimum thickness of 5 mils and conform to AWWA C550, valves shall have a 2-inch standard AWWA operating nut
Hydrants (**See Detail C-8**)			ANSI/AWWA C502-85	Hydrants shall be designed for 150 psi service, hydrants shall open clockwise and must be marked with an arrow and word OPEN to indicate the direction of turn of the stem to open the hydrant, hydrant operating nut shall be 1 1/2", flat to point, pentagonal, hydrants shall have one steamer connection, 41/2" diameter and two hose nozzles, 2 1/2" diameter

MISCELLANEOUS

Gaskets:	AWWA C111/ANSI A21.11	
Cement Lining:	AWWA C104/ANSI A21.4	

NOTE(S):

1. The ductile iron pipe shall be furnished in nominal 18-foot (minimum) lengths with Push on Joints
2. Insulation shall be FOAMGLAS insulation with flexible PITTWRAP jacketing as manufactured by Pittsburgh Corning, or approved equal.
3. City owned valves shall open to the right (clockwise) and MIT owned valves shall open to the left (counter clockwise).

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Pipe Class:			**Material:** Ductile Iron		
Primary ANSI Class: 350			**Primary Material Use:**		
PIPE AND FITTINGS					
ITEM	**SIZE**	**THICK-NESS**	**STANDARD**	**MATERIAL SPECIFICATION**	
Pipe	6” and Larger		ANSI A21.50 AWWA C150/ ANSI A21.51 AWWA C151	Class 52, cement lined, tar coated ductile iron, restrained joint	
Fittings	6” and Larger		ANSI A21.10 AWWA C110 and/or ANSI A21.53 AWWA C153	Compact ductile iron restrained mechanical joint	
VALVES					
TYPE	**USE**	**SIZE**	**STANDARD**	**SPECIFICATION**	
Blow-off Valve (**See Detail C-10**)	Flushing			Blow-off hydrants shall be non-freezing, self-draining type, set underground in a meter box, Blow-off hydrants shall be furnished with a 2” FIP inlet, a non-turning operating rod, and shall open to the left, all of the working parts shall be of bronze-to-bronze design, and be serviceable from above grade with no digging, the outlet shall be bronze and be 2-1/2” NST, Blow-off hydrants shall be lockable to prevent unauthorized use as manufactured by Kupferle Foundry Co., St. Louis, MO, or approved equal	
Post Indicator Valve (**See Detail C-11**)	Block/ Isolation			Provide buried gate valve equipped with a U.L. listed indicator post to display the valve position above ground, a movable target shall move axially in the post to allow a clear view through four opposing windows located 30” above grade level to indicate the “OPEN” position at a distance up to 300 Ft. The openings will be blocked in the “CLOSED” position and reflective white strips on the target shall allow easy position at a distance up to 300 ft. The openings will be blocked in the “CLOSED” position and reflective white strips on the target shall allow easy checking of valve position at night with a flashlight. The physical orientation of the post shall be adjustable so that the windows can be oriented in any direction, the post shall be rigidly constructed of a cast iron barrel. No special mounting adaptors or flanges shall be required. A wrench containing a shear pin shall be provided with each post. The cover and post shall have provision for mounting and locking the wrench and valve position. The post shall receive a coating of Carbit LX6862 red enamel	
MISCELLANEOUS					
Gaskets:	AWWA C111 ANSI A21.11				
Cement Lining:	AWWA C104 ANSI A21.4				

NOTES:
1. The ductile iron pipe shall be furnished in nominal 18-foot (minimum) lengths
2. Fire Protection pipe and appurtenances shall be limited to those listed in the latest version of the Factory Mutual (FM) Approval Guide.

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Pipe Class:		Material: Reinforced Concrete (RCP)		
Primary ANSI Class:		**Primary Material Use:**		
PIPE				
ITEM	**SIZE**	**THICKNESS**	**STANDARD**	**MATERIAL SPECIFICATION**
Pipe	12" and Larger		ASTM C76	Class III/Class IV Reinforced Concrete Pipe (RCP) with rubber gasket joints
MISCELLANEOUS				
Gaskets:	ASTM C443			
NOTE(S):				

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Pipe Class:			Material:	Polyvinyl Chloride (PVC)
Primary ANSI Class:			Primary Material Use:	

PIPE and FITTINGS

ITEM	SIZE	THICKNESS	STANDARD	MATERIAL SPECIFICATION
Pipe/Fittings	4" – 15"		ASTM D3034	Polyvinyl chloride pipe, including those required for stubs, shall conform to ASTM Standard Specifications for Type PSM PVC Sewer Pipe and Fittings, pipe shall have a maximum pipe diameter to wall thickness ratio (SDR) of 35
Fittings	18" - 27"		ASTM F679	Polyvinyl chloride fittings shall conform to ASTM Standard Specifications for Type PSM PVC Sewer Pipe and Fittings,
Joints			ASTM D3212	Joints shall be push-on bell and spigot joints using elastomeric ring gaskets, gaskets shall be of a composition and texture which is resistant to common ingredients of sewage and industrial wastes, as well as petroleum products (oil, gasoline, etc.) and groundwater

NOTE(S):

1. The pipe shall be tested by the flat plate deflection method at a minimum of 45 psi at 5 percent deflection in accordance with ASTM D 2412.
2. S tandard laying lengths of pipe shall be either 13 feet or 20 feet.

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Strainer Table

CLASS	SIZE	STANDARD	SPECIFICATION
100CU	1/2" – 4"		Cast bronze body; 125# rating; threaded joints; "Y" type with 1/8" (maximum) stainless steel or monel screen openings; Mueller Steam Specialty # 351.
	6" and Larger		Cast iron body; 125# rating; flanged joints; "Y" type with 1/8" (maximum) stainless steel or monel screen openings; Mueller Steam Specialty # 758.
125C	1/2" – 2"		Cast bronze body; 125# rating; threaded joints; "Y" type with 1/8" (maximum) stainless steel or monel screen openings; Mueller Steam Specialty # 351.
	2 1/2" and Larger		Cast iron body; 125# rating; flanged joints; "Y" type with 1/8" (maximum) stainless steel or monel screen openings; Mueller Steam Specialty # 758.
125WA	1/2" – 2"		Cast bronze body; threaded joints; "Y" type with 1/8" (maximum) stainless steel or monel screen openings and a minimum rating of 125 psi, 350°F; Mueller Steam Specialty # 351.
	2 1/2" and Larger		Cast iron body; flanged joints; "Y" type with 1/8" (maximum) stainless steel or monel screen openings and a minimum rating of 125 psi, 350°F; Mueller Steam Specialty # 758.
	2 1/2" and Larger (alt.)		Ductile iron body; "Y" type with 1/8" (maximum) stainless steel or monel screen openings and a minimum rating of 125 psi, 350°F; Victaulic S/732.
150	1/2" – 2"		A216 Grade WCB; cast or forged steel body; 150# rating; socket welded joints; "Y" type with 1/32" (maximum) stainless steel or monel screen openings.
	2 1/2" and Larger		A216 Grade WCB; cast or forged steel body; 150# rating; socket welded joints; "Y" type with 1/32" (maximum) stainless steel or monel screen openings.
150C			
150F	1/2" – 2"		A126 Class B; cast or forged steel body; 150# rating; socket welded joints; "Y" type with 1/16" (maximum) stainless steel or monel screen openings.
	2 1/2" and Larger		A216 Grade WCB; cast or forged steel body; 150# rating; socket welded joints; "Y" type with 1/16" (maximum) stainless steel or monel screen openings.
150L	1/2" – 2"		A126 Class B; cast or forged steel body; 150# rating; socket welded joints; "Y" type with 1/32" (maximum) stainless steel or monel screen openings.
	2 1/2" and Larger		A216 Grade WCB; cast or forged steel body; 150# rating; socket welded joints; "Y" type with 1/32" (maximum) stainless steel or monel screen openings.
300	1/2" – 2"		A216 Grade WCB; cast steel or forged stainless steel body; 300# rating; socket welded joints; "Y" type with 1/32" (maximum) stainless steel or monel screen openings.
	2 1/2" and Larger		A216 Grade WCB; cast steel or forged stainless steel body; 300# rating; butt welded joints; "Y" type with 1/16" (maximum) stainless steel or monel screen openings.
300C			

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THICKNESS OF PIPE INSULATION (FIBERGLASS)

	Nominal Pipe Diameter				
Fluid Design Operating Temp °F	1” & Less	1” to 2”	2 1/2”to 4”	5” & 6”	8” & Up
Heating System					
Above 400°F	2.5	2.5	3.0	3.5	3.5
252 to 400°F	2.0	2	3	4	4
201 to 250°F	1.5	1.5	2.0	2.0	3.5
141 to 200°F	1.5	1.5	1.5	1.5	1.5
105 to 140°F	1.0	1.0	1.0	1.5	1.5
Domestic & Service Water 105°F and more	1.0	1.0	1.5	1.5	1.5
Cooling Systems					
40°F to 55°F	1.0	1.0	1.0	1.5	2.0
Below 40°F	1.0	1	1	1.5	1.5
Cold Water Service	.5	.5	1.0	1.0	1.5

Notes:

1. The primary insulation material is to be fiberglass. In special circumstances other types may be required. When using different insulation types, follow manufacturer’s recommendations and procedures.
2. Materials: Cover piping with the fiberglass insulation with All Purpose Jacket AP-T Plus. Use Aluminum Jacket for piping outdoors.
3. Application: The thickness of pipe insulation shall be in accordance with Table 1 above.

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Domestic Water

1) Service pipe

   a. Service pipe shall be type “K” copper tubing, American manufactured. All service fittings shall be extra heavy brass.

   b. All services greater than 1” shall have the valve box installed at the corporation.

2) Corporations

   a. Corporations for 1” services shall be heavy pattern, solid plug, easy turning and of a type equal to the Mueller H-10003 or Ford FB 1600 Series.

   b. 1 _” and 2” corporations shall be of the ball valve type similar to the Ford FAFB-1600 Series or an approved equal.

3) Curb stops

   a. For 1” services, the curb stop shall be of a type equal to the Ford FGB-44 series.

   b. Service boxes shall be Erie style, American manufactured, of a telescopic type with a length from 4 to 5 feet. The cover shall be extra grade iron.

4) Valve Boxes

   a. Valve boxes shall be cast-iron, tar coated, sliding type, consisting of three (3) pieces: a flanged bottom piece, a flanged top piece, and a cover with two (2) lifting holes.

   b. Valve boxes shall be installed vertically, centered over the operating nut, and the elevation of the top shall be adjusted to conform with the finished surface.

Stormwater

Manholes (See Precast Concrete Drain Manhole Detail C-**3**)

1) Precast reinforced concrete manhole sections shall conform to the applicable requirements of ASTM C478, latest revision. Concrete shall have a minimum 28-day compressive strength of 4,000 psi, utilizing Type II Portland cement. Reinforcement steel shall be intermediate grade, ASTM A615, and deformed in accordance with ASTM A615. Welded wire fabric shall conform to ASTM A185. Manholes shall be designed to withstand AASHTO HS-20 loading.

2) Four (4) foot diameter manholes shall have a minimum wall thickness of five (5) inches and bottom minimum thickness of eight (8) inches. Five (5) foot diameter manholes shall have a minimum wall thickness of six (6) inches and minimum bottom thickness of eight (8) inches.

3) Frames and covers shall have a 24-inch diameter clear opening and shall be manufactured by LeBaron Foundry, Model LK-110, or equal.

4) Frames and covers shall be of cast iron with diamond cover surface design and designed for AASHTO HS-20 loading.

5) Manhole steps for precast reinforced concrete barrel sections shall be steel encapsulated with molded copolymer polypropylene plastic step.

6) All drainage manholes shall have a 4 foot sump for sediment collection.

Catch basins (See **Precast Concrete Catch Basin C-2**)

1) Precast concrete catch basin shall conform to the applicable requirements of ASTM C478 or ASTM C858, latest revision and designed to withstand AASHTO HS-20 loading.

2) Precast concrete sumps (6' minimum depth) shall conform to the applicable requirements of ASTM C478. Wall sections shall have a minimum wall thickness of six (6) inches.

3) Frames and Grates shall be cast iron, minimum class 25 conforming to ASTM A48 and capable of withstanding AASHTO HS-20 loading.

4) Frames and grates shall be Lebaron Foundry, Model LF248-2, or equal.

5) Two 4-inch weep holes shall be provided with each catch basin. The pipe through the catch basin wall shall be PVC and a 1/2-inch mesh 23 gauge galvanized wire shall be secured at the end of the pipe to keep the stone out. Two cubic feet of stone sized 3/4-inch to 1-1/2-inch shall be placed around each weep hole. In areas of contamination or high groundwater, weepholes shall not be provided.

Brick

1) Brick shall comply with the ASTM Standard Specification for “Sewer Brick (made from clay or shale)”, Designation C32, for Grade SA, hard brick.

2) The mortar for brickwork shall be composed of Type II Portland cement and sand in the proportions of 1:2. The sand shall comply with the “Standard Specifications” for “Fine Aggregate”, for concrete masonry.

Sanitary Sewer

Standard Manhole (See **Sanitary Sewer Precast Concrete Manhole Detail C-12**)

1) All manholes shall have precast concrete bases at least 6-inches thick for 4-foot diameter manholes and 8-inches thick for larger manholes. The precast bases shall be manufactured to contain wall openings of the minimum size to receive the ends of the pipes.

2) Manhole walls shall be precast concrete sections conforming to the applicable requirements of ASTM “Tentative Specifications for Precast Reinforced Concrete Manhole Sections,” Designation C478, latest revision.

3) The top conical section shall have a wall thickness not less than 5-inches at the bottom and wall thickness of 8-inches at the top. The conical section shall taper from a minimum of 48-inches diameter to 24-inches diameter at the top.

4) Gaskets for sealing the joints between manhole sections shall be of petroleum resistant materials of a special composition having a texture to assure a watertight and permanent seal. The gasket shall be of a composition and texture, which shall be resistant to sewage, industrial wastes, petroleum products, and groundwater.

5) Flexible pipe-to-manhole connectors shall be Kor-N-Seal or equal.

6) Frames and covers shall have a 24-inch diameter clear opening and shall be manufactured by LeBaron Foundry, Model LK-110, or equal.

7) Frames and covers shall be of cast iron with diamond cover surface design and designed for H-20 loading.

8) Covers for all structures shall have the word “SEWER” cast upon them.

9) Manhole steps for precast reinforced concrete barrel sections shall be cast in with barrel sections and of steel encapsulated with molded copolymer polypropylene plastic step.

Brick

1) Brick shall conform to the applicable requirements of ASTM Standard Specification for “Sewer Brick (made from clay or shale)”, Designation C32, for Grade SA, hard brick, latest revision.

2) The mortar for brickwork shall be composed of Type II Portland cement and sand in the proportions of 1:2. The sand shall comply with the “Standard Specifications” for “Fine Aggregate”, for concrete masonry.

Ductbanks

Conduits (Piping)

1) Conduits shall be manufactured of PVC, Carlon PV-Duct, Type 40, 90° UL rated or approved equal.

2) Material shall have a tensile strength of 7,000 psi at 74.3° F, flexural strength of 11,000 psi and compressive strength of 8,600 psi.

Manholes\Vaults (See Typical Electrical/Telecommunication Manhole Plan Detail C-5)

1) Telecom and electrical vaults shall be precast reinforced concrete. Concrete shall be 5000 psi at 28 days. Reinforcing steel to comply with AASHTO M31, grade 60.

2) Manhole walls and base slab to be 6" thick (min.), top slab to be 8" thick (min.).

3) Pulling eyes to be 1 1/4" diameter with nuts and washers, all galvanized.

4) Frames and Covers shall be cast iron and shall be equal to Pattern No. LE280, diamond cover surface design as manufactured by Lebaron Foundry, Inc., or approved equal.

5) Manhole exterior is to be dampproofed.

Design Review Checklist

1) Plan view drawings are to be at a scale of 1” = 20’.

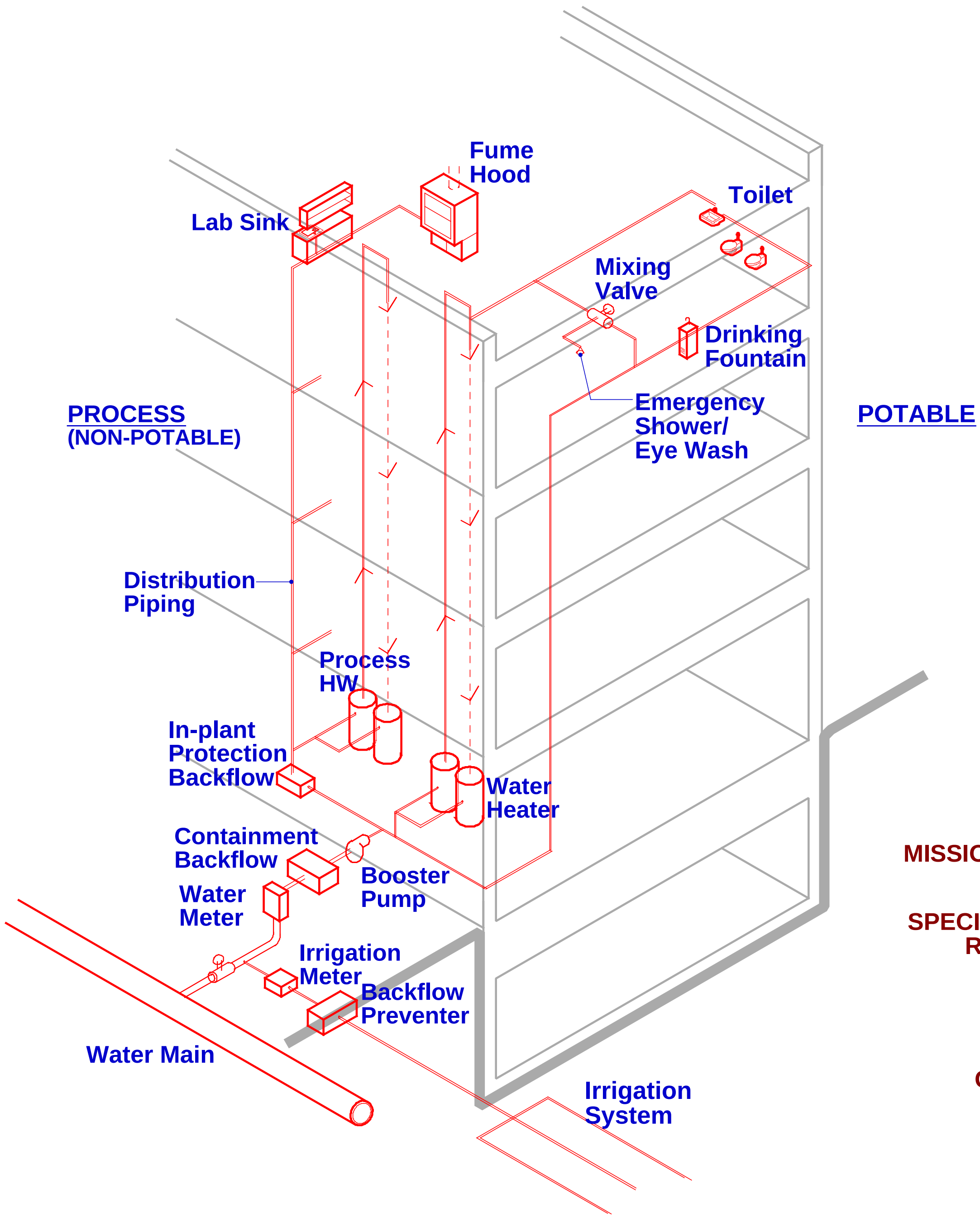
2) Existing conditions drawings (including existing utilities) are to be provided.

3) Profile drawings (including existing drawings0 shall be provided.

4) Cross section drawings shall be provided at key locations for clarity.

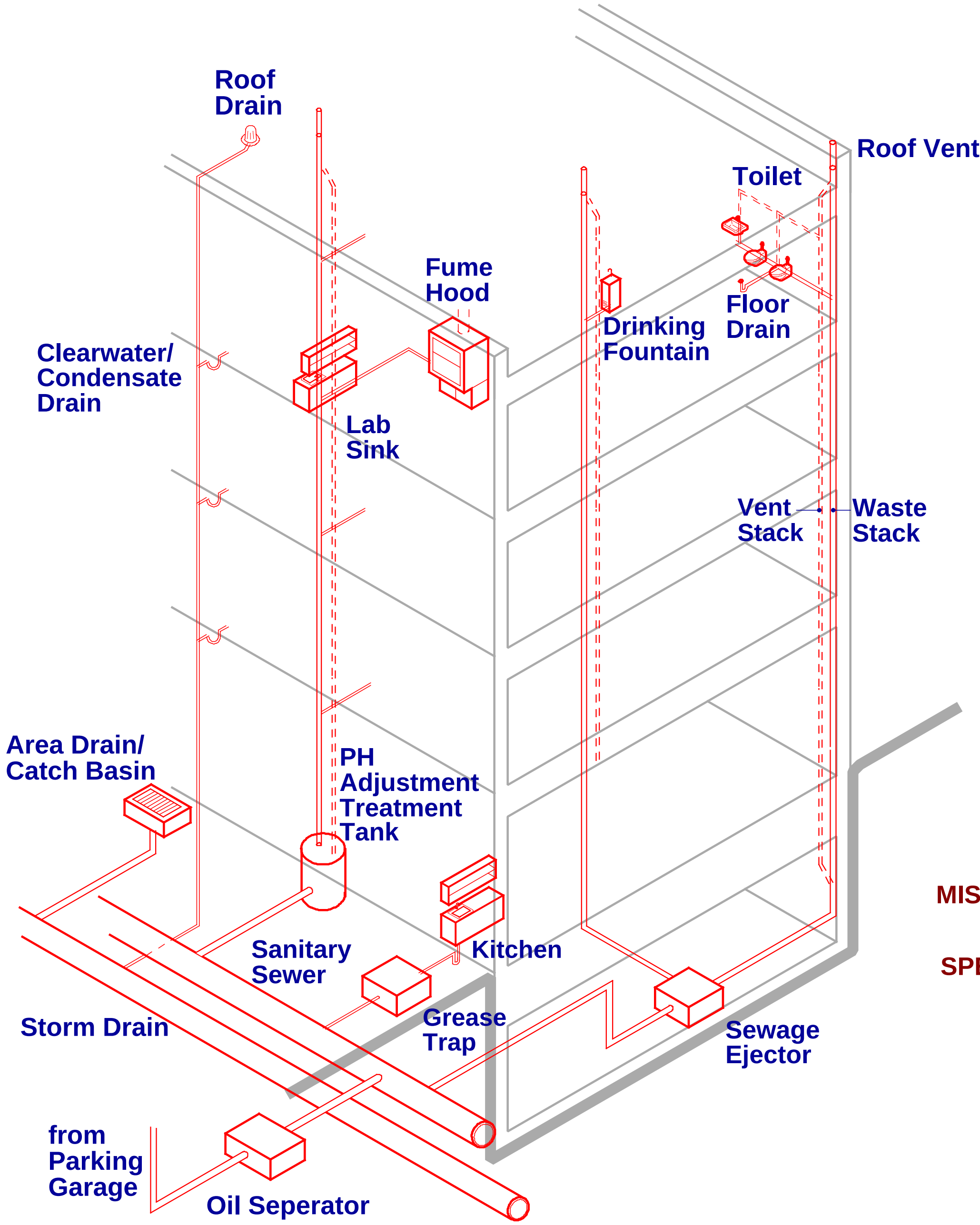
5) Technical specifications for all aspects of the construction shall be provided.

_______________________________________**Signature of Engineer**



PLUMBING: WATER SUPPLY

(click here for Waste Water)
(click here for Required Engineering Documents)



PLUMBING: WASTE WATER

(click here for Water Supply)
(click here for Required Engineering Documents)

Mission Statement

It is our mission to provide safe, reliable and efficient plumbing systems that are designed to conserve water, energy and the environment. To achieve these goals, we commit ourselves to adhere to all pertaining codes, regulations and industry standards. We will provide redundancy where necessary to achieve uninterrupted service and minimize downtime. We will provide sufficient design flexibility to allow for future expansion. As an institute of technology, we will keep an open mind to design proposals that incorporate new technology and innovative approaches to plumbing engineering.

Top Ten List of Common Plumbing Design Issues

(not prioritized)

1. All piping shall be labeled.
2. All valves shall be ball valves unless otherwise noted or agreed upon with MIT Facilities.
3. Any existing lead-lined piping shall be replaced as it is discovered during renovations.
4. All drain valves at bottom of risers 2 1/2” and larger shall be 1 1/2” size with 1 1/2” threaded fire hose connection.
5. All water heaters in academic buildings shall be steam semi-instantaneous.
6. All condensate from air conditioning coils shall be piped indirectly to storm.
7. All domestic water booster pumps shall be vertical, multi-stage with variable speed drives. Control panels are to display inlet pressure, discharge pressure, flow, totalized flow, and pump status.
8. All valves in chases are to be installed so as to be accessible for repair and replacement.
9. In general, the first three to four floors of a building shall be fed potable water directly from street pressure. A pressurized express main shall feed upper floors.
10. Irrigation water is to be metered by independent city meters to facilitate sewer abatements.

Special MIT Design Criteria

Metering Requirements, City Water

1. Provide appropriate and cost effective metering of city water with isolation valve on discharge side of meter.
2. Provide a full size valve up to 2 1/2" with threaded hose connection at the outlet side of the city water meter. This is to be used for meter calibration, temporary feed to the building, and system draining.
3. All city water meters shall read in cubic feet.
4. With the exception of irrigation and cooling tower make-up meters, The City of Cambridge Water Department will supply water meters for services 2" and smaller. These meters are Neptune meters, AWWA C700.
5. For services 2 1/2 " and larger and for all irrigation and cooling tower make-up meters, specify Metron-Farnier single-jet water meters. These meters are to be supplied and installed by the Contractor.
6. All meters shall be provided with manufacturer's remote registration hardware. Hardware shall include a wall-mounted accessory pad for communications.
7. Fire protection services are not to be metered.
8. Install dedicated water meter(s) for cooling tower make-up and in-ground irrigation systems. These meters are not sub-meters to a main meter. These meters shall be fed directly from the water service entry, separate from the rest of the building, upstream of the domestic water meter. These meters are used to facilitate the tracking of sewer rebates with the city.
9. Meters inside the building shall be installed in an accessible location. Exterior meter pits or vaults are not allowed.
10. Wherever possible, remove existing meters in exterior pits and vaults and relocate inside the nearest building.
11. Water used at a construction site shall be metered by the contractor and billed to the respective construction project account.

Backflow Prevention

1. Refer to "Plumbing Products" table on pages 6-8 of this section for acceptable backflow device manufacturers.
2. All backflow devices shall have ball valves for isolation. Gate valves are not allowed. All ball valves 4" and larger shall be American Valve or Watts G-4000-FDA.
3. Project specifications shall include the following under Part 3 – Execution:
   "Flush water lines prior to backflow testing to clear piping of sediment. Test all backflow devices and provide written record of each test result to MIT Facilities. A third-party certified tester shall perform all tests. Rectify all test discrepancies prior to MIT acceptance. Provide one spare parts kit to MIT for each size backflow device."
4. Backflow devices with flange or body material dissimilar to the connected piping shall be installed with a dielectric kit supplied by the backflow device manufacturer.
5. All backflow devices shall be supplied with a 20-mesh strainer at the inlet.
6. Unless a fire pump is installed, strainers are not required for double check valves in fire protection services.
7. Where fire pumps are installed, provide a 20-mesh strainer body and strainer for fire pump testing and certification. This strainer is required to prevent foreign matter frequently present in new services from fouling the fire pump. After certification, remove the strainer element from the strainer body.

Booster Pumps

1. Water pressure on campus can vary significantly from day to night and from season to season. Pressure ranges from 40 psig to 60 psig.

2. Buildings over four stories shall have a booster pump system to maintain pressure.
3. Split systems: The basement through fourth floor shall be fed off of street pressure when practical. An express main from the booster pumps will feed the upper floors. This is to conserve energy by avoiding pressurizing water above 80 psig only to subsequently reduce pressure through a pressure-reducing valve to feed lower floors.
4. All domestic water booster pumps shall be vertical, multi-stage with variable speed drives. Control panels are to display inlet pressure, discharge pressure, flow, totalized flow, and pump status.

Water Heaters

1. Water heaters in academic buildings shall be semi-instantaneous whenever possible.
2. Instantaneous water heaters shall not be used on potable hot water systems.
   a. Instantaneous water heaters are defined as heat exchangers where the water to be heated is in the coil and the steam is in the jacket.
   b. Semi-instantaneous water heaters are defined as heat exchangers where the water to be heated is in the jacket and the steam is in the coil. With an internal thermostatic control, these heaters are far more accurate.
3. Where a reduced pressure zone backflow preventer is installed in the domestic water supply, an expansion tank shall be installed in the cold water feed to the potable water heaters.
4. When storage type water heaters are used, storage temperature shall be from 140ºF to 150ºF to inhibit bacterial growth. This requirement is especially important in dormitory buildings and buildings with shower facilities where occupants can be exposed to aerosolized hot water.
5. Hot water distribution temperature shall be between 110ºF to 120ºF. Thermostatic mixing valves shall be used to convert to hot water storage temperature to distribution temperature.

Exterior Hose Spigots (Wall Hydrants)

1. All exterior hydrants shall be frost proof.
2. All exterior hydrants shall have vacuum breakers.
3. Wherever possible, specify hydrants with flush access door with removable tee handle.

Pressure Gauges and Related Instruments

1. All pressure gauges, switches and transmitters shall have 1/2” isolation ball valves.
2. Provide pressure gauges at the inlet and outlet of each pump, backflow preventer and pressure-reducing valve.

Drinking Fountains

1. Recess drinking fountains in alcoves. Do not project into corridors.
2. Provide dual height units as required to meet barrier-free accessibility requirements.

Toilet Room Fixtures

1. Wall hung lavatories are preferred. Avoid the use of countertops.
2. Where countertops are used, specify an under-mount bowl to eliminate any lip or dam at the sink edge.
3. Lavatory selection and design shall be easy to wipe clean and prevent trapped water outside the sink bowl.
4. All public lavatory faucets shall be mechanical metering faucets. MIT does not prefer electronic sensor faucets.
5. MIT does not prefer the use of electronic sensor flush valves on water closets or urinals.
6. Wall hung water closets are preferred. Avoid the use of floor-mounted fixtures.

7. Water closets are to be flush valve operated. The flush valve handle shall be on the approach side of the water closet in barrier-free stalls.

Natural Gas

1. Determine the current gas supply company.
2. Review the preliminary gas system design with the gas provider early in the design process and regularly thereafter.
3. The gas company will make the connections to the gas main and will provide the service branch to the building. MIT may be back-charged for this expense.
4. File total connected load for new gas consumption with the gas company in writing.
5. The gas company typically furnishes and installs the gas meter.
6. Provide swing joints at buildings as required by codes and standards to account for building settlement.
7. Refer to laboratory services sections of the MIT Code for laboratory gas requirements.

Sewage Ejectors and Sump Pumps
All sewage ejectors and sump pumps in basins deeper than 4 feet shall be specified with rail removal systems.

Emergency Shower and Eyewash Systems

1. ANSI Z358.1 (latest edition) and 527 CMR 10.02 shall be followed in all respects when installing emergency showers and eyewashes on campus.
2. Flushing water to showers and eyewashes shall be tempered. Tempered water range shall be between 65ºF and 90ºF with a preferred temperature of 85ºF
3. Thermal Storage:
   a. Whenever possible, tempered water shall be supplied through a semi-instantaneous steam-fired water heater. This heater may be the potable water heater for the building. The intent is to mini mize thermal storage required for ANSI flushing water supply requirements.
   b. When semi-instantaneous heaters are not possible, MIT prefers the use of dedicated electric storage water heaters to provide the 15 minute tempered water requirements of ANSI.
   c. Storage water heaters shall have a minimum combined storage capacity of 220 gallons at a storage temperature of 150ºF.
   d. Storage temperature requirements are intended to mitigate *Legionella pneumophila* proliferation in stagnant water supplies. Higher temperature also allows a higher specific enthalpy thereby reduc ing storage volume.
4. Thermostatic mixing valves shall be set for 85ºF and designed to provide full cold-water bypass on failure of the hot water supply.
5. Thermal storage shall be sized for one emergency shower and one emergency eyewash flowing for 15 minutes. Minimum delivery temperature shall not be less than 60ºF after fifteen minutes.
6. Flushing water supply pressure to emergency showers and eyewashes shall not be less than 30 psig and shall not exceed 80 psig. Where water supply pressure is inadequate to supply the 30 psig minimum
   residual at design flow, include a booster pump in the tempered water system.
7. Pipe sizing shall be based on two emergency showers flowing simultaneously without regard to delivery temperature.
   a. Minimum main distribution shall be 2” in diameter.
   b. Branch distribution to a floor shall be not less than 1 1/2” in diameter.
   c. Feeds to individual equipment shall follow ANSI requirements.

Pipe and Valve Identification

1. Provide color-coded pipe identification markers on all installed piping.
2. Pipe markers shall be plastic tape type protected by clear acrylic coating. Refer to “Plumbing Products” table on pages 6-8 for approved manufacturers.
3. Label mains as follows:
   a. at all points of entrance and exit from mechanical rooms,
   b. adjacent to each valve,
   c. on each riser between each floor,
   d. at each tee fitting,
   e. at points of entrance and exit from building,
   f. at least once each room,
   g. at intervals no longer than 20 feet.
4. For pipe 4” and larger, legend shall be 2” high. For pipe 3” and smaller, use 1/2” high legend.
5. Install arrow markers with each identification marker to indicate direction of flow. If flow can be in either direction, use double-headed arrow marker.
6. Markers shall have band colors and legend as follows:

Service	Legend	Band Color	Legend Color
Cold Water	Potable Cold Water	Green	White
Hot Water	Potable Hot Water	Green	White
Hot Water Return	Potable Hot Water Return	Green	White
Sanitary Drain	Sanitary Sewer	Green	White
Sanitary Vent	Sanitary Vent	Green	White
Rainwater	Storm Drain	Green	White
Natural Gas	Natural Gas	Yellow	Black
Garage Waste	Garage Waste	Green	White
Garage Vent	Garage Vent	Green	White
Reclaimed Water	Gray Water	Yellow	Black
Flushing Water*	Flushing Water	Yellow	Black
Irrigation Water	Non-Potable Water	Yellow	Black
Boiler/CHW Make-up	Non-potable Water	Yellow	Black
Pure Water Make-up	Non-potable Water	Yellow	Black

* Flushing water piping shall be painted along its entire length in yellow enamel paint prior to insulation. Pipe shall then be stenciled in black paint “Toilet and Urinal Flushing Only.” After insulation, provide pipe label as specified in this table. This procedure is mandatory; deviation shall require special approval of the State Board of Examiners of Plumbers and Gas Fitters.

Products

Item	Preferred Manufacturers	Spec Type	Remarks
Toilet Room			
Lavatories	American Standard		
	Kohler		
	Eljer	OP	
Lavatory Faucets	Delta		
	American Standard		
	Kohler		
	Chicago		
	Symmons	OP	
Hose Bibs	Chicago		
	T&S Brass		
	Water Saver	OP	
Shower Units	None	OS	
Shower Valves	Symmons		
	American Standard	OP	
Water Closets	American Standard		
	Kohler		
	Eljer	OP	
Urinals	Kohler “Bardon”		
	K-4960-T		
	American Standard		
	Eljer	CP	
Flush Valves	Sloan Royal	CP	
Supplies & Stops	None	OS	
Shower and Toilet Room Floor Drains	J.R Smith		
	Zurn		
	Ancon		
	Wade	OP	
Janitor’s Sinks			
Basin	Fiat	OS	
Faucet	None		
Coffee Sinks			
Bowl	Elkay		
	Just	OP	
Faucet	Elkay		
	Chicago		
	Delta		
Drinking Fountains	Oasis		
	Halsey Taylor	CP	

Item	**Preferred Manufacturers**	**Spec Type**	Remarks
Floor Drains, Roof Drains, Area Drains, Planter Drains	J.R Smith		
	Josam		
	Zurn	OP	
Equipment			
Backflow Preventers	Watts Model 909		
	Watts Model 709	CP	
Press/Temp Gauges	Ashcroft		
	U.S. Gauge		
	Trerice	OP	
Booster Pumps	Syncroflo		
Pressure Reducing Valves	Watts	OP	
	Patterson-Kelly		
	ACE	CP	
Water Heaters, Gas/Oil	Aerco	CP	
Water Heaters, Electric	A.O. Smith	OP	
Water Heaters, Electric	POU		
	EEMax	OP	
Sewage Ejectors	Flygt		
	Weil	CP	
Sump Pumps	Flygt		
	Weil	CP	
Tempering Valves	Leonard		
	Lawler		
	Powers	OP	
Emergency Shower Valves	Leonard		
	Lawler		
	Powers	OP	
Valves			
Ball	Apollo (Conbraco)		
	Watts		
	Nibco	OP	
Gate/Butterfly/ Check	Nibco		
	Stockham		
	Milwaukee	OP	
Wall Hydrants	J.R. Smith		
	Josam		
	Zurn	OP	

Item	Preferred Manufacturers	Spec Type	Remarks
Grease Traps	J.R. Smith		
	Zurn		
	Rockford	OP	
Gas and Sand Interceptors	Rockford	OP	
Pipe Markers	Seton “Setmark”	OP	
Water Meters			
< 2” Services	Neptune	CP	
2 _” and Larger	Metron-Farnier	CP	
Irrigation			
Thermostatic Mixing Valves	Lawler		
	Leonard		
	Powers OP		
Emergency Showers/ Eyewashes	Guardian		
	Encon		
	Haws		
	Water Saver		
	Chicago	OP	
Insulation	Owens-Corning		
	Manville		
	Certain-Teed	OP	

Legend:

OS: Open specification. MIT has no predetermined preference. Follow accepted industry practices.

OP: Open Proprietary. Manufacturers listed are preferred, however, other products may be submitted for MIT approval on a case-by-case basis.

CP: Closed Proprietary. Only the manufacturer(s) listed may be specified. This does not preclude the opportunity for other manufacturers to present alternative products to MIT for consideration. Suchproducts will be reviewed for:

1. Time in market. Five years minimum is generally required,
2. Longevity. The product must be at least as durable as other products listed.
3. References. Where has the product been installed previously?
4. Local service. Can a local vendor make a service call within 24 hours?
5. Quality of local service. Has the vendor/manufacturer serviced MIT satisfactorily in the past?

Green Design

<u>Gray water reclaim for flushing water</u>

1. Whenever practical and economical, consideration shall be given to collecting gray water waste for recycled use as irrigation water or flushing water.

2. Reverse osmosis reject water should be reclaimed whenever possible to be used as irrigation or flushing water.

3. Reclaim water systems shall not be employed in childcare facilities.

<u>Rainwater reclaim for flushing and irrigation</u>

<u>Low consumption fixtures</u>

<u>Controlled flow roof drainage</u>

Operations

(This section to be added)

Environmental Health and Safety

Gray Water Labeling

1. Refer to the Pipe Identification Table, Note 1.

Emergency Shower And Eyewash Systems

1. Consult with MIT EH&S for the location of all emergency first aid equipment including emergency eyewashes and showers.

Drinking Water Quality

1. Certain buildings on campus, particularly in the Main Building Group, have small amounts of residual lead-lined piping in the potable water systems. This is original piping used when these campus buildings were constructed. The pipe exterior looks like galvanized steel.

2. Whenever a renovation reveals these existing pipe materials, the Contractor shall inform MIT Facilities. MIT Facilities will arrange to have this pipe material removed and replaced.

3. Connection of new water piping to existing lead-lined materials is strictly prohibited.

Institute Spaces
Art, Architecture and Preservation

(This section to be added)

Laboratory Services

(This Section to be ADded)

Design Review Checklist

The Design Consultant is responsible for filling out and submitting this checklist at each phase of design as a guide for design review by MIT Facilities.

Schematic Design

1. Review of applicable codes and regulations
2. System descriptions (Basis of Design)
3. Alternative design concepts
4. Outline specifications
5. Equipment cut sheets
6. Statement of probable costs

Signed: ______________________________(Plumbing Engineer/Designer)

Design Development

1. Specification of water meters,
2. Meter remote registers coordinated with MIT Facilities,
3. Piping and metering of irrigation water,
4. Design of split water distribution system, as applicable,
5. Variable speed drive domestic booster pumps, as applicable,
6. Calculations of water distribution pressure and flow,
7. Water heater selection,
8. Hot water storage temperature, as applicable,
9. Tempered water system design,
10. Chase wall sizes coordinated between plumbing and architectural,
11. Natural gas systems,
12. Natural gas load calculations,
13. Natural gas loads filed with the gas company,
14. Elevated gas pressure permit filed, as applicable,
15. Flushing water system design, as applicable,
16. Flushing water variance application filed, as applicable,
17. Flushing water load calculations,
18. Controlled Flow roof drain design, as applicable,

19. Location of all emergency showers and eyewashes shown, as applicable,
20. Emergency shower and eyewash locations reviewed with MIT EH&S,
21. Location of sanitary vent terminals with respect to HVAC air inlets,
22. Piping of HVAC condensate to storm,
23. Trap primers are installed where required,
24. Coordination of plumbing with HVAC,
25. Coordination of plumbing with electrical,
26. Sprinkler drains and compressed air service supplied to fire protection systems,
27. Garage waste sand and oil interceptor design reviewed with plumbing inspector,
28. Grease interceptor design reviewed with plumbing inspector,
29. Updated fixture and equipment cut sheets provided,
30. Reclaimed water system(s) reviewed with plumbing inspector and application for variance filed with State board, as applicable.

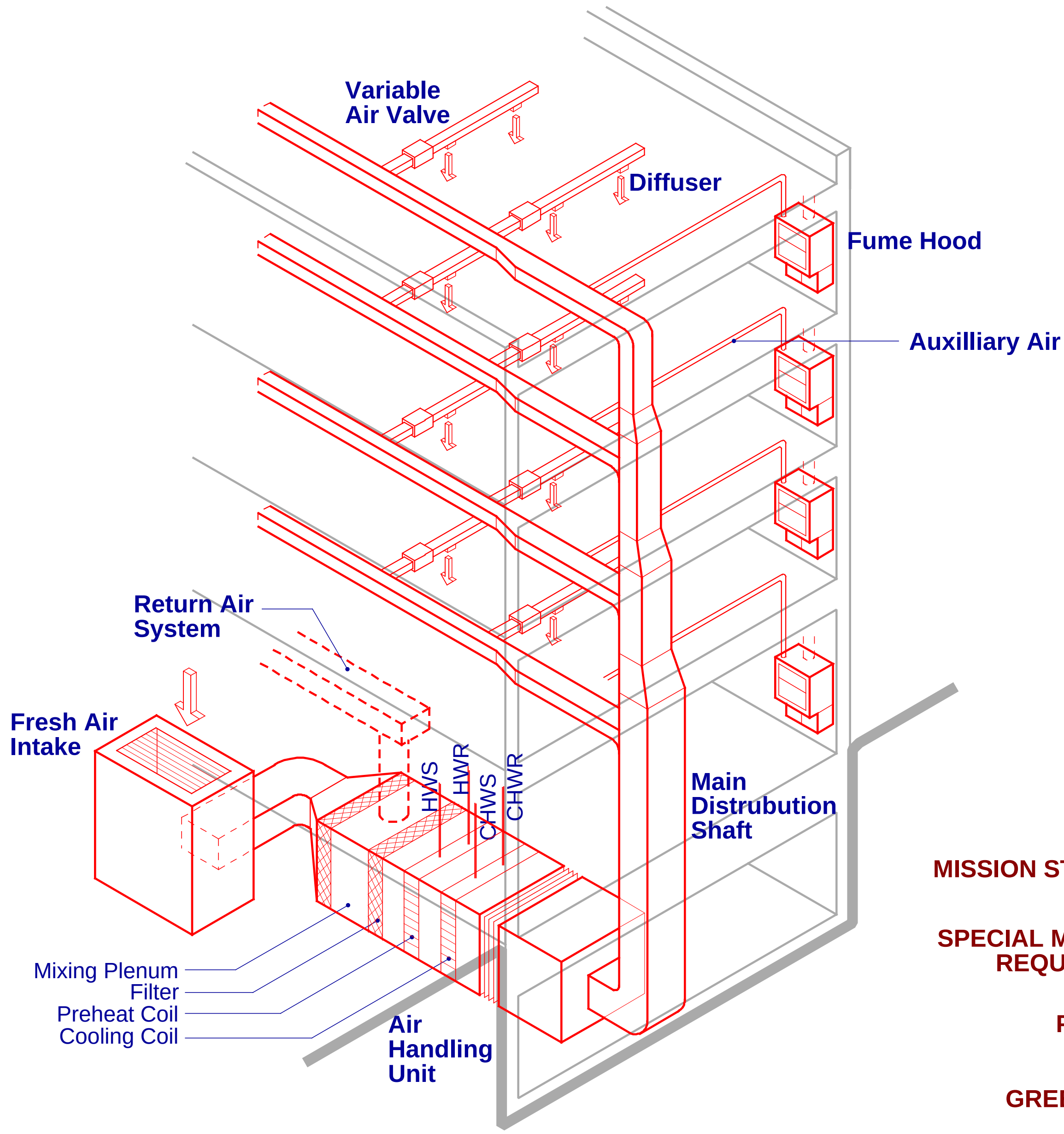
Signed: ________________________________(Plumbing Engineer/Designer)

Contract Documents

1. List of design changes from the Design Development issue,
2. Updated fixture and equipment cut sheets,
3. Natural gas loads/permits approved by gas company and/or State Board,
4. Flushing water system approved by State Board,
5. HVAC condensate coordinated with storm water system,
6. Electrical loads coordinated with electrical drawings,
7. Any other variances approved by responsible authorities,
8. Review of specification sections.

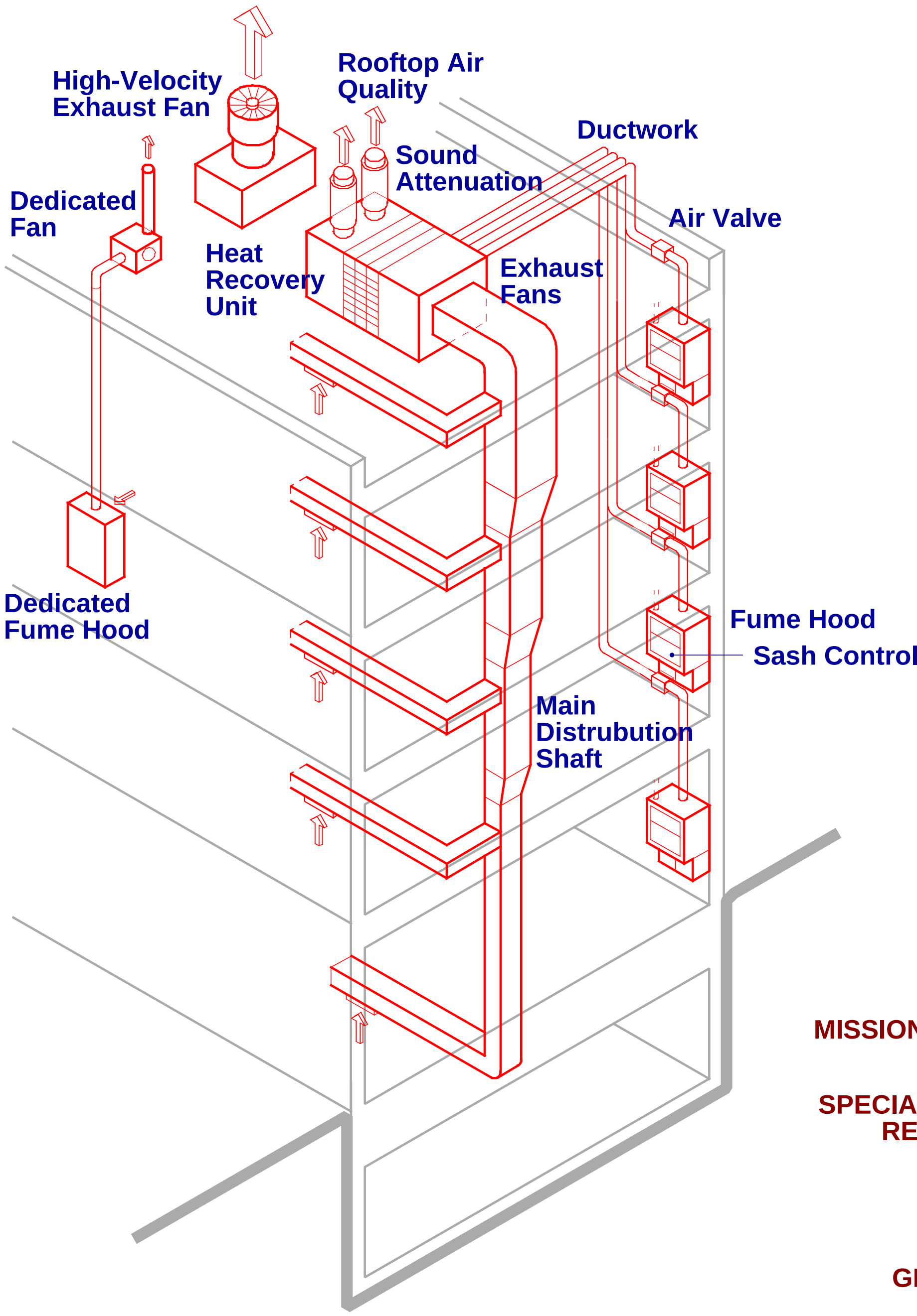
Signed: ______________________________(Licensed Engineer Stamping and Signing Drawings and Affidavit)

END OF SECTION



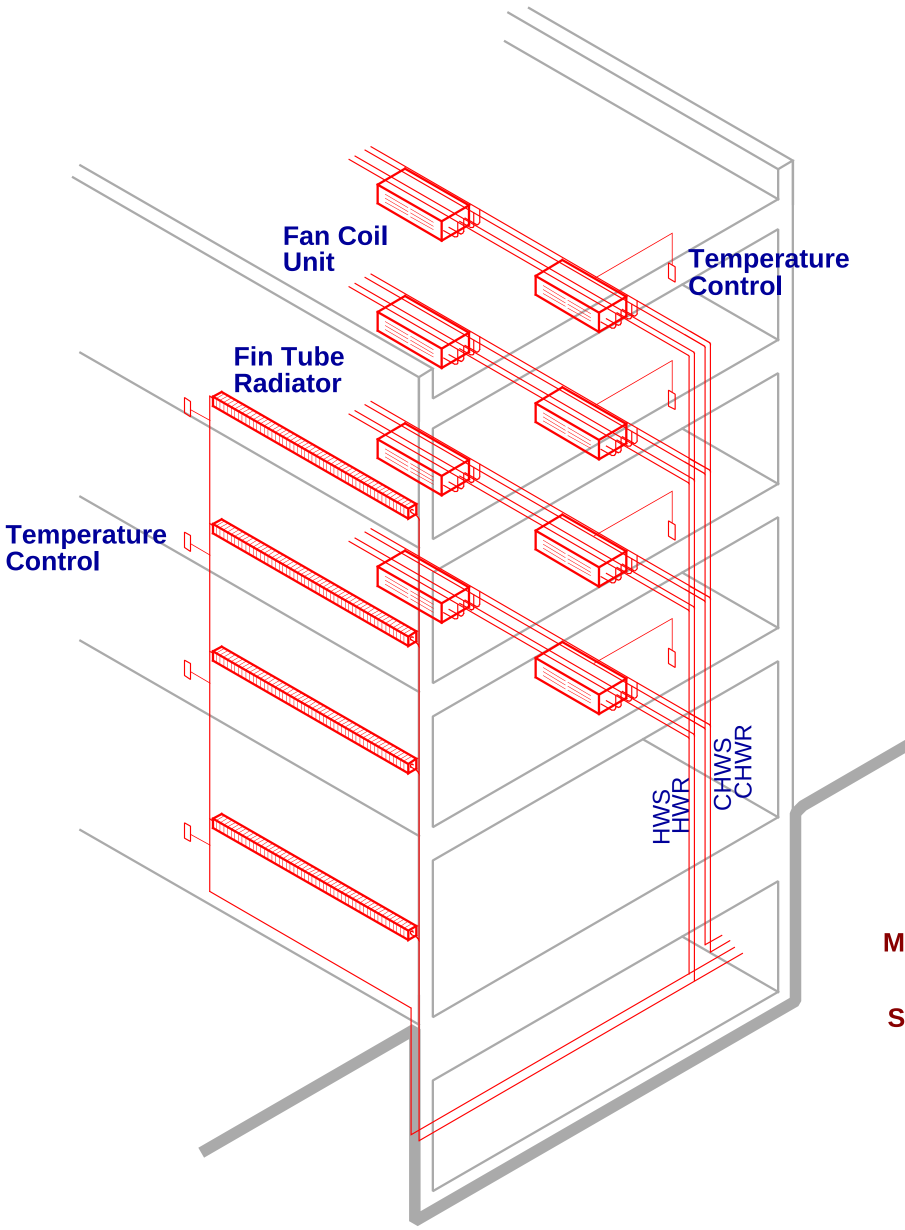
HVAC: VENTILATION - SUPPLY

(click here for Ventilation - Exhaust system)
(click here for Heating & Cooling system)
(click here for Required Engineering Documents)



HVAC: VENTILATION - EXHAUST

(click here for Ventilation - Supply system)
(click here for Heating & Cooling system)
(click here for Required Engineering Documents)



MISSION STATEMENT A

SPECIAL MIT DESIGN REQUIREMENTS B

PRODUCTS C

GREEN DESIGN

OPERATIONS

EHS

INSTITUTE SPACES ART, ARCHITECTURE & PRESERVATION

LABORATORY SERVICES

DESIGN REVIEW CHECKLIST

HVAC: HEATING & COOLING SYSTEM

(click here for Ventilation system)
(click here for Required Engineering Documents)

Mission Statement

1. HVAC system design and equipment selection should presume an operating life of 40 years.
2. Equipment location and housing should provide easy access for maintenance, repair, replacement and day-to-day operation.
3. As an institute of technology, MIT is particularly receptive to HVAC design innovations which reduce cost and maintenance and improve safety.
4. HVAC designs and installations at MIT should provide an acceptable level of air quality and comfort, minimize energy use, and install materials that are safe for the environment.
5. It is not the intent of this code to limit designs or creativity, but to provide guidelines for consultants and contractors to follow and to stimulate discussions, questions and exchange of information.
6. The requirements for new buildings versus renovations in existing buildings may vary significantly. To reduce economic and practical inefficiencies associated with renovations, in many instances, M.I.T. has undertaken long term master planning which may include provisions for expansion of certain systems and building components. Therefore, design teams should always review project requirements and determine whether such previously built-in expansion provisions exist. These systems presented here are suggested.

Top Ten List of Common HVAC Design Issues

(not prioritized)

1. Do verify coordination among the HVAC, Plumbing, and Electrical disciplines:
   a. Confirm that make-up water is supplied to humidifiers, cooling towers, closed systems, etc
   b. Confirm that power is supplied to all equipment requiring electrical power.
   c. Confirm that appropriate electrical power voltage and phase are supplied as specified in the HVAC schedules.
   d. Confirm that disconnects are provided, fused or otherwise, for HVAC equipment.
   e. Confirm that drains are provided in mechanical rooms.
   f. Confirm that condensation drains are directed to storm system.
   g. Confirm that gas service is provided where required.
   h. Confirm that auxiliary contacts are supplied for control interface.
   i. Confirm requirements for emergency power.

2. Do verify that all project consultants (not only other MEP consultants) have reviewed the drawings, have submitted comments and have received responses to the comments, including acoustics, code, and kitchen consultants as well as structural engineers.

3. Do provide a complete code review confirming all required provisions including those for:
   a. Fire dampers, smoke dampers, smoke detectors, etc.
   b. Hi-rise/smoke proof enclosures.
   c. Atriums including requirements for exhausting atriums.
   d. Electrical rooms including any ductwork and/or piping conflicts.
   e. Hazardous Exhaust (Fume Hoods), including these requirements:
      1. Ducts must remain inside defined fire zone or laboratory unit.
      2. A fire-rated dedicated shaft to roof is provided.
      3. Sprinklers are provided above PVC ducts and at tops of duct shafts. No sprinkler heads may be provided inside fume hood exhaust ductwork.

4. Do complete review of engineering calculations and assumptions
   a. Outside air/ventilation.

(See **Required Engineering Documents** in Division 1 General Requirements)

b. Steam
c. Chilled water

5. Do review MEP space layouts and service access
   a. Shaft space.
   b. Mechanical/Electrical Rooms and Penthouses.
   c. Spot check ductwork.
   d. HVAC equipment installed in ceiling space.
   e. Service and Code clearances

6. Do review controls sequences (all equipment included):
   a. "Safeties" including freeze protection.
   b. Smoke control/smoke evacuation.
   c. Fume hood exhaust sequences for air side balance.
   d. Smoke dampers/smoke detectors.
   e. Interface with MIT campus system.
   f. Interface with MIT Facilities Constrol System (FCS).
   g. Pneumatic/electric actuation

7. Do review riser and flow diagrams of all systems:
   a. Spot check air flow.
   b. Concentrate on chilled water system, steam systems and hot water systems flow diagrams and valve locations.
   c. Focus on known problem areas such as chilled water pumps.

8. Do make all equipment accessible and provide adequate clearance for maintenance

9. Do verify utilities and infrastructure in existing building:
   a. Chilled Water Systems
      1. Building pump station capacity and differential pressure
      2. Pump operation schedule
      3. Differential pressure without pumps.
   b. Steam Systems
      1. Year-round steam source for:
         a. Hot water reheat systems
         b. Central station air handling systems
      2. Operating pressures.
      3. Building perimeter steam heating system.
   c. Hot Water Systems
      1. Operating temperatures
      2. Operating schedule
      3. Capacity
   d. Dual Temperature Systems
      1. Operating Temperature
      2. Capacity
   e. Ventilation Systems
      1. Operating Schedule
      2. Capacity (for expansion)
   f. Fume Hood Supply and Exhaust Air Handling Systems
      1. Capacity (for expansion)
   g. Compressed Air Temperature Controls
      1. Operating Pressure
      2. Capacity

10. Do make sure all equipment is appropriately labelled and that nomenclature conforms to MIT standards.
    a. Pipe and duct identification
    b. Equipment identification
    c. Valve tags

11. Do review compliance and design within MIT departments:
    a. Systems Engineering
        1. Automatic temperature controls
        2. Utilities, metering
    b. Central Utilities
    c. Safety Office and Insurance Underwater
    d. Industrial Hygiene Office (EMS)
    g. Repair & Maintenance
    h. CAD Systems Department.
    g. Science Research Group--end user.

Special MIT Design Criteria

Index:

Design Comfort Thresholds

Basic temperature standards are 68 degrees F for heating and 78 degrees F for cooling. Specific uses and applications may require different comfort guidelines. For example, a cooling setting of 78 degrees may be too high for when outdoor temperature is in the 60's and 70's and occupants are more warmly dressed. Proposed design comfort levels (heating and cooling operating standards) must be approved by the M.I.T. Project Manager early in the design phase.

Design Paramters for HVAC Systems

In general, the following guidelines apply. Obtain approval of the design guidelines for each project for M.I.T. Project Manager early in the design phase. Comfortable transitions between heating and cooling are required.

1. Heating – Outside Temperature — 7º F, 5641 degree days Base 65
2. Heating – Inside Conditions — 72ºF
3. Cooling – Outside Dry Bulb Temperature — 87ºF
4. Cooling – Outside Wet Bulb Temperature — 74ºF
5. Cooling – Inside Conditions — 78ºF
6. Humidity – Typically, there is no humidification. If humidification is required, do not use chemically treated boiler steam directly for humidification.
7. Ventilation Air: Ventilation rates should be minimized but always maintained within the acceptable parameters established by ASHRAE, M.I.T. Project Manager and building codes. In general, 20 CFM of outdoor air per person should be provided system wide.
8. When designing small air systems, which combine ventilation and cooling for a few zones, locate the cooling coils in the ductwork downstream of the supply fan. This will ensure that well mixed air is delivered to the coils and provide individual cooling zones. This configuration allows the system cooling coils to remain flooded all winter, eliminating disruption and expense associated with seasonal winterization. This application shall be reviewed with the M.I.T. Project Manager.
9. When designing 100% outside air system for ventilation only (office and lab ventilation) or ventilation and cooling (VAV systems) use an external bypass arrangement that is a full bypass design (bypasses the heating and cooling coils), whenever possible. If an external bypass design is not possible, use a full face heating coil on the air handling unit.
10. For systems where discharge temperature control in the heating mode is not critical, a full face coil

provides freeze protection for the chilled water coil located after it. Be sure to have the unit controlled and monitored by M.I.T. FCS. This will allow the cooling coil to remain flooded through the winter, eliminating the disruption and expense associated with seasonal winterization.

11. Where relative humidity is not critical, such as ventilation for offices/corridors, miscellaneous makeup air, etc., consider use of face and by-pass damper arrangement to control air flow through cooling coils during peak cooling season. This will allow partial dehumidification and higher mixed air temperature downstream of the coils preventing overcooling discomfort in spaces and lower chilled water usage. Reheat coils downstream of air handling units will not be required with this design. Pay attention to potentially high relative humidities at 65 degree discharge air. Proper mixing of air streams at unit is essential to prevent condensation in the fan section.
12. Water Wasting Units: It is M.I.T.'s intent to eliminate all "waste water" cooling units over time. In the renovation of any space which has such a unit, it should be removed and replaced as necessary as a part of the project.
13. Verify operating temperatures and pressures and capacity of infrastructure and utilities such as chilled water and pumping capacity, steam capacity, condensate return and pumping capacity, hot water heating and pumping capacity, etc.

Design Strategy for Areas Without Active Mechanical Ventilation System

There are a number of buildings and areas on campus without active ventilation systems--some sytems have older, inoperable components, both moving and static; others were never provided with mechanical ventilation systems.

1. Recommendations:
   a. A workable approach for renovating spaces without active ventilation has been to install new systems which draw in a constant amount of outside air and distribute that air througout the renovated area. This arrangement allows future projects to provide the outdoor air component from a new central source.
   b. Spaces with operable windows may comply with code ventilation requirements without mechanical ventilation systems. There are also some low occupant density areas that may be adequately served by window leakage, even in winter.
   c. A renovated space that is isolated from a windowed space required some mechanical ventilation . Often when a ventilation system in included for this reason, it is extended to serve the windowed spaces too.
2. Types of spaces that are exceptions to the above-stated strategies:
   a. High occupant density areas such as classrooms, lecture halls, conference rooms.
   b. Laboratories which make-up ventilation because of specialized exhaust requirements.

Design Strategies for Chilled Water Piping Systems

1. Generally, many buildings on campus have a chilled water pumping station with approximately two to three pumps. Each pump station generally shall include a bypass line with check valve. Due to demand, the campus secondary chilled water distribution system has a lower differential pressure available during the peak cooling season and a higher differential pressure available during the non-peak periods (winter and shoulder seasons). Also, many buildings, which may be in close proximity to the chilled water plant, will have a higher differential pressure available than those buildings, which are further away. It has been the strategy of M.I.T. to disable (building) pumps when they are not needed due to the higher available differential pressure from the chilled water plant pumping system. During these periods, chilled water through a building can be circulated directly from the campus loop using the pump station bypass and check valve without operating the building pumps. When designing a chilled water distribution system for an existing or new building verify with M.I.T. Project Manager the need for
   a. Pumping station

b. Peak differential pressure
c. Off peak differential pressure

2. Generally, chilled water distribution piping shall be sized for an average pressure drop of 1.5 feet of head per 100 feet of pipe. Depending on the available differential pressure at the building, this design parameter may decrease or increase. Where applicable, design and size piping distribution systems with consideration for future expansion.
3. Where available differential pressures are high or fluctuate, consider use of pressure independent flow control valves, similar to "Delta P-Valve", to modulate the flow through the valve. Use of this valve shall be reviewed with the M.I.T. Project Manager. Typically, this valve would be used at a cooling coil in place of an automatic control valve and balancing valve.

4. Automatic air vents shall not be used. Provide manual air vents using ball velve, cap and chain turned down.

Design Strategy for Steam Heating Systems

1. Generally, M.I.T. does not use steam as the perimeter heating medium for newer buildings due to limited controllability. Generally, for new buildings or fully renovated buildings, a perimeter hot water heating system as either part of a heating only system (finned tube radiation), two pipe heating and cooling changeover system (fan coil units) or four pipe system (fan coil unit) wheres heating and cooling is available are used depending on the building type. The type of system to be provided should be reviewed with the M.I.T. Project Manager early in the design. Hot water heating systems should be low temperature compensated based on outdoor air temperature.
2. At start-up systems shall be filled using city water. Thereafter, closed and independent piping systems requiring make-up water typically shall have water made up automatically from the chilled water distribution system as opposed to city water. This avoids the need for back flow preventers. Some systems such as those used for cooling lab equipment will require a relatively cleaner source of water. These systems shall use city water both at start-up and automatically to make-up water. A backflow preventor will be required.
3. Many buildings at M.I.T. have existing low pressure perimeter steam heating systems which are cycled on and off throughout the heating season. Where perimeter radiation lacks control, it is the strategy of M.I.T. to provide individual pneumatic control or self-contained control valves. Where possible, shut off valves on steam supply and return lines to radiators, within renovation area, should be provided for routine maintenance and to avoid building wide shut downs. For larger renovation projects, consider removing the perimeter steam heating system and replacing it with a hot water system.
4. Campus steam distribution system operating pressures to buildings vary from either 200 psig or 60 psig. When connecting to these systems for renovations which might include air handling units, year round hot water reheat systems, domestic hot water heaters, a reliable steam source must be validated or connect to. Review the requirements for steam with the M.I.T. Project Manager. Provide pressure reducing stations and specialties per the M.I.T. standards.
5. Condensate pumps, where required, should be sized to overcome system back pressures. Review required discharge pressure with the M.I.T. project manager and perform an Engineering study as required.
6. Generally, automatic air vents shall not be used for hydronic piping systems. Provide manual air vents using ball valve cap and chain turned down.
7. Typically, strainers shall be provided at water pumps. Do not provide strainers at terminal equipment. Review requirements with M.I.T. Project Manager.

Design Strategy for Lab Equipment Cooling

1. Many research labs have requirements for water cooling of equipment. The type of system whether an open versus closed system or local versus central system and the advantage and disadvantage of each, should be evaluated and documented early in the design and reviewed with the M.I.T. Project Manager and the end user. Typically, these systems may require:

a. Tight temperature tolerances.
b. Glycol due to low operating temperatures.
c. High or very low operating pressures.
d. Special water filtration.
e. Use of non-ferrous piping materials.
f. User control and adjustability.
g. Reliability (redundancy and city water backup).
h. Dew point control of space temperature to prevent condensation on research equipment cold surfaces.
i. Chemical treatment

2. These piping systems where the end user periodically connects and disconnects lab equipment, by means of hoses, may require the use of automatic air vents to remove air. Manual air vents will not provide an adequate means of air removal as it is introduced into the system (when the lab equipment hoses are connected to the piping system).
3. The requirements for these cooling water systems will be discussed further under the "Lab Services" Section.
4. Typically, strainers shall be provided at water pumps. Do not provide strainers at terminal equipment. Review requirements with M.I.T. Project Manager.

Design Strategy for Areas with Auxiliary Type Fume Hoods

1. There are a number of buildings and areas on campus where auxiliary air hoods are utilized. Typically, these are used with in rare cases where high hood density exists and supply air to hoods cannot be provided without causing poor hood performance operation. Generally, part of the make-up air for these hoods is provided at the hood supply duct collar and plenum. This air is filtered and tempered in the winter and typically unconditioned in the summer. There is an increasing concern regarding safety due to build up of condensation inside the fume hoods and the potential reactions with uncertain chemicals. As a result, in areas where this type of fume hood is to remain and be used, tempering of the make-up air during the summer cooling season must be considered. This should be reviewed with the M.I.T. Project Manager and M.I.T. EMS-IHO. The following conditions may exist:
   a. Conditioned air is supplied to room. Raw or unconditioned air (summer) is supplied to fume hood.
   b. Raw or unconditioned air (summer) is supplied to fume hood. Cooling in lab is provided by fan coil units.
   c. Conditioned air is supplied to room. Secondary filtered and tempered 70ºF to 75ºF air (normally this would be used for return air) is supplied to fume hood.
   d. Unconditioned raw air is supplied to room (summer) and unconditioned raw air is supplied to fume hood. Laboratory is not air conditioned.
2. Possible upgrades and corrections, which should be considered to provide conditioned (summer) air to fume hoods, are as follows. These upgrades should be reviewed with M.I.T. Project Manager. Modifications and extent of upgrade will be dependent on the size of the renovation, available budget, feasibility, project life and age and condition of existing equipment.
   a. Central Air Conditioning Unit: Provide a cooling coil and drain pan in unit to serve the entire air handling system. Review requirements for all unit components downstream of cooling coil and ductwork which may need insulation and vapor barrier.
   b. Duct Mounted Cooling Coil: Provide a cooling coil at the unit discharge in the ductwork to serve the entire air handling system. Review insulation and vapor barrier requirements.
   c. Duct Mounted Zone Cooling Coil: Provide a cooling coil at point of use to serve isolated renovation areas which may have this type of fume hood. Review insulation and vapor barrier requirements.
   d. Air Conditioning: It is the intent of M.I.T. to provide air conditioning in all laboratories. In areas where heating and ventilating only units exist, consider replacing the central station units to upgrade for full cooling of laboratories. Supplemental cooling using fan coil units should also be considered. Review requirements for reusing or replacing auxiliary air fume hoods with M.I.T. EMS-IHO.

Design Strategy for Cooling Laboratory Areas

1. Generally, it is the philosophy of M.I.T. to provide for energy-efficient design. In laboratories where recirculating type fan coil units are allowed to be used, the make-up air required for the fume hoods can be quite high resulting in air change rates as high as 30 to 45 air changes per hour or higher. With a variable volume fume hood exhaust and supply air system, the turn down can be significant (4:1), resulting in reduced operating cost and installed cost since central systems can be down sized due to diversity. In some cases, the minimum air flow at maximum turn down in a laboratory exhaust air and supply air system may be quite low resulting in insufficient cooling.
2. In order to maintain the required cooling, a temperature override sequence would be required where general exhaust air valves are opened as the supply air valve opens, to maintain a negative differential pressure and air flow in the lab. In these cases, to avoid using heated and cooled 100 percent outdoor air to provide air conditioning it is the philosophy of M.I.T., in the interest of energy conservation, to provide fan coil units in the laboratory for supplemental cooling. This will avoid using 100 percent outdoor air through temperature override to cool laboratories. The feasibility and initial cost implications of providing fan coil units must be reviewed with the M.I.T. Project Manager.

Design Strategy for Air Handling System Zones

1. Air handling systems (supply and exhaust) should be zoned to serve areas of similar use and occupancy schedules where possible. If this is not possible, occupied/unoccupied VAV terminals should be provided to shut down areas not in use.
2. In new building designs, air handling systems and duct distribution should not cross building lines. Air handling systems shall be dedicated only to the building they serve.
3. Unfortunately, there are a number of areas on campus where air handling units serve more than one building and cross building demising walls. During system shut downs, this makes it very difficult to notify user groups in advance of shut downs due to the difficulty of defining all of the areas the unit serves. This results in a user group not being notified and a potential valuable loss of research time. In these areas, it is the strategy of M.I.T. to separate building systems, utilities and services. These systems, which do cross building demising walls and are within the project renovation area and beyond, must be evaluated and reviewed with the M.I.T. Project Manager. The systems should be separated by dedicating the air handling unit to one building only, and if necessary, adding an air handling unit and distribution system to the other building. Cost implications may determine the feasibility of this approach and design.

Design Parameters for Laboratories

1. In laboratories, excellent air circulation and ventilation is needed to create the correct environment for research and for safety. Location of supply air relative to hazardous exhaust should be reviewed. Recirculation of laboratory air between lab units is not acceptable. Recirculating fan-coil units and induction units serving labs individually are acceptable. Air from offices, conference rooms, classrooms and similar spaces can and should be recirculated, and may be used for make-up air for lab exhaust and fume hoods.
   a. Chemical Laboratories: Positive exhaust ventilation is required at all times. During non-use, volume of air exhausted may be reduced for energy conservation. Fail safe design must be used which provides for override in the event of after hours work. The volume of ventilation and ventilation systems proposed must be reviewedwith the M.I.T. Project Manager and M.I.T. Industrial Hygiene Office (EMS-IHO) early in the design phase. Rates may vary from 6 to 12 air changes per hour as a minimum. Coordinate special exhaust requirements including equipment enclosures, local snorkle exhaust, (ovens, vacuum pumps), bench exhaust, chemical storage cabinets, flammable storage cabinets, glove box, etc.

   b. Animal Housing Areas: Provide ventilation, temperature, relative humidity and filtration to comply with National Institute of Health laboratory design criteria and standards and to comply with M.I.T. EMS requirements. Evaluate the potential for energy conservation; consider the use of air to air heat exchanges.

c. Enclosed work spaces such as laminar flow exhaust hoods or bio-safety cabinets may also have to satisfy containment criteria if hazardous substances are being used. This type of usage may also require that the equipment be vented directly through a hard duct connection to outside the building. A separate exhaust fan may be required. Be sure to consult EMS on any type of hood application.

d. Environmental Controlled Temperature Rooms: Cold rooms, warm rooms and freezer rooms often have equipment such as condensing units which can significantly affect the HVAC design loads of nearby spaces. Verify equipment to be used and loads to be created early in the HVAC design phase. Environmental Controlled Temperature Rooms may also need exhaust.
e. Heat Rejecting Equipment: Verify heat rejecting equipment to be used and loads to be created early in the HVAC design phase.
f. Operable Windows: Operable windows shall not be used in laboratories or spaces where differential pressure and air flow is critical to the design and safety. In existing buildings, operable windows shall be locked closed.
g. Positive Pressure or Clean Laboratories: The requirements and approval for a positive pressure laboratory and chemicals used shall be reviewed with M.I.T. EMS-IHO. Often these rooms will require the need for a negative pressure anti-room. These requirements should be reviewed early in the design.

4. Fume Hoods: Section 11610 – Fume Hoods. Use only fume hoods identified in Section 11610.
   a. Auxiliary Air: For energy efficiency, fume hoods using auxiliary air to minimize the volume of conditioned room air exhausted should use tempered air [+/-65ºF] in winter and summer.
   b. Ductwork: Fume hood ductwork is usually low flame spread PVC ASTM-D-1789-69 Class 12454-B or welded stainless steel. Evaluate combustibility issues related to plastic ductwork and evaluate firestopping issues on a project specific basis.
   c. Exhaust Fans: Fume hood exhaust fan motors and belts should not be in the air stream so that they can be maintained with minimum exposure to exhaust fumes. For safety, fans are typically "always on". Variable volume air systems should be considered to reduce exhaust air volume as fume hood sash is lowered. The recapture of energy by use of a heat exchanger should be evaluated, but safe discharge must not be compromised. Obtain MIT EMS approval of fume hood exhaust designs.
   d. Dampers: Do not provide discharge dampers for single fume hoods or single fans.
   e. Face Velocity: See guideline Section 11610 – Fume Hoods.
   f. Roof Mounted Equipment: Fume hood exhaust fans should be located on a roof or in a roof penthouse with the fewest pressure parts within the penthouse. If a penthouse is used, additional space may be needed for scrubbers, filters and other pollution control equipment which may be needed in the future. For roof-mounted equipment, provide guardrails or enclosures around the equipment which are approved by MIT Safety Office, unless high parapets are provided. Maintain proper clearances with adequate space to service and replace equipment. Achieve at least 2,500 fpm velocity. The top of the discharge stack must be at least 10 feet above general roof level and away from large rooftop structures such as penthouses.
5. Environmental Controlled Temperature Rooms: Cold rooms, warm rooms and freezer rooms often have equipment such as condensing units which can significantly affect the HVAC design loads of nearby spaces. Verify equipment to be used and loads to be created early in the HVAC design phase. Environmental Controlled Temperature Rooms may also need exhaust.
6. Heat Rejecting Equipment: Verify heat rejecting equipment to be used and loads to be created early in the HVAC design phase.
7. All fume hoods shall have an exhaust air flow monitor.

Fume Hood Exhaust Systems

Review requirements with MIT EMS-IHO. Refer to Section 11610 "Fume Hoods" for all requirements and coordination.

1. Fume Hoods: Section 11610 – Fume Hoods. Use only fume hoods identified in Section 11610.
   a. Auxiliary Air: For energy efficiency, fume hoods using auxiliary air to minimize the volume of fully conditioned room air exhausted should use tempered air [+/-65ºF] in winter and partially conditioned air (+\- 60ºF) in the summer.
   b. Ductwork: Fume hood ductwork material shall conform to low flame spread Type I, grade 1, PVC ASTM-D-1784-69 Class 12454-B or welded stainless steel. Review use of 304 versus 316 stainless and gauge. Evaluate combustibility issues related to thermo plastic ductwork and evaluate firestopping issues on a project specific basis.
   c. Exhaust Fans: Fume hood exhaust fan motors and belts should not be in the air stream sot that they can be maintained with minimum exposure to exhaust fumes. Use backwardly inclined fan wheels to assure stable operation. For safety, fans are typically "always on". Variable volume air systems should be considered to reduce exhaust air volume as fume hood sash is lowered. The recapture of energy by use of a heat exchanger should be evaluated, but safe discharge must not be compromised. Obtain M.I.T. EMS approval of fume hood exhaust designs.
   d. Dampers: Do not provide automatically controlled discharge dampers for single fume hoods or single fans. Do not use back draft dampers.
   e. Face Velocity: See guideline Section 11610 – Fume Hoods.
   f. Roof Mounted Equipment: Fume hood exhaust fans should be located on a roof or in a roof penthouse with the fewest positive pressure parts within the penthouse. If a penthouse is used, additional space may be needed for scrubbers, filters and other pollution control equipment which may be needed in the future. For roof mounted equipment, provide guardrails or enclosures around the equipment which are approved by M.I.T. Safety Office, unless high parapets are provided. Provide lighting and service outlets. Maintain proper clearances to permit space to service and replace equipment. Achieve at least 2,500 fpm velocity. The top of the discharge stack must be at least 10 feet above general roof level and away from large rooftop structures such as penthouses.
2. Constant volume exhaust air fume hoods shall be used where dictated by:
   a. Type, use and constant dilution required (i.e., radioactive isotopes, perichloric acid, etc.).
   b. Minimum room ventilation dictates the use of constant volume.
   c. Economic feasibility does not allow for variable volume exhaust and variable volume make-up air.
   d. Consider sash limit stops at 20" height. Must have physical stop, which can be overriding and alarms which can be muted for setup only.
   e. Consider horizontal sash as opposed to vertical sash to reduce air flow and energy usage.
   f. Minimum fume hood face velocity shall be 100 feet per minute at design such opening. If greater air flows are required to meet room air change rates, provide a general exhaust at ceiling.
3. Variable Air Volume Exhaust Fume Hoods and Make-up Air
   a. Consider variable volume exhaust and supply make-up air with Phoenix controls where the type, use and dilution does not require constant volume exhaust.
   b. Consider use of horizontal sash operation if hood is greater than six feet in length. If required by end user, consider the use of a combination vertical sash and horizontal sash type fume hood.
   c. Fume hood face velocity shall be minimum 100 feet per minute.
   d. Variable volume fume hood minimum exhaust air flow rate shall be not less than 50 CFM per linear foot of fume hood.
4. Manifold Exhaust Air Systems
   a. Generally, fume hoods are not required to be individually exhausted by a dedicated exhaust air fan. Fume hoods may be manifolded into a common exhaust air system combined with a general lab exhaust air system providing manifolding is performed per the BOCA 1993 Mechanical Code and NFPA 45. When manifolding fume hoods, careful considerations should be given to labs with same type use, defining a laboratory unit and fire zone, fire separation in shafts and horizontally. Typically manifolded systems provide for increased dilution of chemicals. Manifolded systems should be reviewed with MIT EMS-IHO.
   b. Systems which are manifolded on the roof outdoors should be designed with careful consideration for pitch and drainage of condensation, expansion and contraction, insulated duct if it will be part of a heat recovery system. PVC ductwork is subject.
   c. Larger manifolded systems should be welded stainless steel duct as opposed to PVC duct. PVC duct

is subject to cracking due to expansion and contraction extremes, is brittle in cold weather, is UV sensitive and heat sensitive.

d. Type 2 PVC duct should be used outdoors.
e. PVC (thermoplastic) duct up to 12-inch diameter may be solvent welded. PVC duct over 12-inch diameter should be hot gas welded.
f. PVC (thermoplastic) duct has a high smoke spread and should not be used in return air plenums.
g. Chemical Storage Cabinets (chemical storage/flammable storage): Generally, chemical storage cabinets shall be exhausted using stainless steel. Cabinets shall be exhausted at a minimum rate of 50 CFM. Cabinets shall be specified with multiple air inlets to achieve exhaust rate and avoid excessive pressure drops. Follow NFPA 45.
h. Vacuum Pumps: A means shall be provided to exhaust pump discharge (indirect connection) at a minimum rate of 50 CFM. Confirm with end user pump discharge rates and increase air volume as required for multiple discharges into one snorkel exhaust. Review with M.I.T. EMS-IHO.
i. Coordinate sprinkler head locations to be installed above PVC duct and at top of the shafts. Do not install sprinkler heads inside PVC duct.
j. Manifolded exhaust systems shall have redundant fan capacity.
k. If energy recovery is provided, a means of servicing coils and changing filters must also be provided either by use of multiple fans, filters and coils with diversity or redundancy. Shutting down one fan during off-peak periods or in systems which have redundant fans, filters and coils allow for routine maintenance to be performed without a system wide shut down if properly dampered. If this is not possible, a means must be provided for a dampered bypass duct around air filters and coils to allow for routine maintenance without system shutdown.

5. Determine laboratory air change rates. Review with MIT EMS-IHO.
   a. 6 air changes per hour minimum.
   b. 8 air changes per hour recommended.
   c. 10-12 air changes per hour for special conditions.

Fume Hood Air Balancing

1. All testing, adjusting and balancing of the fume hood exhaust air, general exhaust air and variable volume supply air with reheat coils shall be tested, recorded and reported at minimum, intermediate and maximum air flows. Average face velocities at fumehood sashes shall be 100 FPM minimum at all sash positions at a maximum of +/-0.7 negative water gauge at the exhaust connection. Eliminate all adverse conditions such as air drafts caused by supply registers and transfer air grilles. Test all fumehoods at a maximum room supply air volume and 55 degrees and minimum air volume and 55 degrees at maximum air volume. Balancing reports shall be forwarded to M.I.T. EMS-IHO for final review and approval of fume hood and laboratory exhaust air requirements.

Fume Hood commissioning

1. Commissioning of fume hood shall not be performed by manufacturer. All new or remodled fume hoods must have ASHRAE 110 testing conducted at the design opeining or opeinings. The sash movement effect test must be conducted on varieable air volume hoods. In general once face velocity and smoke test hace been passed, the five minute average test results for the tracer gas testing must be less than or equal to 0.1 PPM for all operating conditions tested. Forward all reports to M.I.T.-I.H.O. immediately (617-253-2596) if ther fume hood fail any portion of the test.

Transformer Rooms

1. Provide ventilation to comply with requirements of guideline Section 16400 – Electrical Service and Distribution. Evaluate cooling versus ventilation. Coordinate load with Electrical section.

As-Built Record Drawings

1. Record drawings must be high-quality, easily-readable, carefully-drafted reproducible drawings produced by carefully and accurately redrafting the Contract Documents to show clearly all deviations from the original Contract Drawings, the precise location of each item of work, and all field changes. Record Drawings must be submitted to and approved by MIT as a prerequisite to final payment to the Contractor.
2. Electronic Documents: Provide electronic copies of all as-built record documents, both drawings and specifications. Drawings shall be AutoCAD compatible and specifications and written documents shall be Microsoft Word compatible. For more detailed information on preparation and format of AutoCAD drawings, contact the Physical Plant CAD System Administrator through the MIT Project Manager.

MIT Facilities Drawings and Standard Details

1. MIT may have CAD documents, depending on the project location and scope, of facility related information and standard details, which may be of value to the Designer for integration into the construction documents. To determine the availability of these documents, contact the CAD Systems Administrator through the MIT Project Manager. The Designer shall be responsible for the usability and appropriateness of these documents.

Products and Materials

List of Products and Materials

1. The following is a list of equipment and materials which should be reviewed and discussed with the M.I.T. Project Manager. The manufacturers listed are suggested for the basis of design and not to limit construction and have been used successfully at M.I.T.
2. Description: Manufacturer:

Description	Manufacturer
Fan Coil Units	-
Central Station Air Conditioning Units	-
Humidifiers	-
Fan Powered Terminal Units	-
Laboratory Airflow Control System	Phoenix
Accoustical Duct Lining	-
Ceiling Diffusion	-
Registers and Grilles	-
Exhaust Fans	-
Lab Exhaust System Components	-
General Exhaust System Components	-
Motors	-
Variable Frequency Drives (See Division 16)	-
Automatic Temperature Controls	Andover Controls

Ductwork

1. Fume hood ductwork is usually low flame spread PVC ASTM-D-1789-69 Class 12454-B or 304 or 316 welded stainless steel. Evaluate combustibility issues related to plastic ductwork, and evaluate fire-stopping issues on a project specific basis. Outdoors or on roof use Type II, grade 1, high impact, UV resistant PVC ASTM D-1784 Class 14333-D. Consider cost savings to use stainless steel.

Fans

1. Exhaust Fans: Fume hood exhaust fan motors and belts should not be in the air stream so that they can be maintained with minimum exposure to exhaust fumes. For safety, fans are typically “always on”. Fume hood or lab local system exhaust fans should be equipped with backwardly inclined fan wheels in order to provide desirable exhaust system characteristics and stable operation. Exceptions must be approved by MIT EMS. Variable volume air systems should be considered to reduce exhaust air volume as fume hood sash is lowered. The recapture of energy from the exhaust by use of a heat exchanger should be evaluated, but safe discharge must not be compromised. Obtain MIT EMS approval of fume hood exhaust designs.

Dampers

1. Do not provide discharge dampers for single fume hoods or single fans. Do not use backdraft dampers on fume hood or specialized local exhaust systems. For systems with redundant fans, use blast gates for fan isolation. Butterfly dampers may be used as balancing dampers for fume hood and specialized exhaust systems.

Central Station Air Conditioning Units

1. Double wall construction with solid inner liner.
2. Fans: Higher efficiency and generally quieter wheels shall be used where possible.
3. Bedrings selected for fatigue life rating L10 of 200,000 hour operation.
4. Statically and dynamically balanced fan wheels to 0.10 inch/second at peak velocity.

5. Fixed pitched sheaves shall be used. Adjustable pitch shall be used at start-up only, then replaced with fixed pitch. Provide multiple belt-type sheaves.
6. Internal fan isolation where possible.
7. External face and bypass dampers around both heating and cooling coils. All heating coils must also have valve control.
8. Spacer section between steam preheat coil and cooling coils for service access, installation of freeze stats and proper mixing of air before cooling coil. Provide with access door on both sides..
9. Vertical or horizontal steam coils with integral face and bypass dampers may be used. For variable air volume systems allow increased distance between these heating coils and cooling coils to allow for full mixing of bypass air and heated air during low turndown. During lower airflows, air may still be destratified causing nuisance tripping by freezestat mounted on face of cooling coil. In these cases, provide turbulators or mixing baffles down stream of steam coils to increase mixing.
10. Steam Coils
    a. Determine whether condensate return system within the building is or shall be a wet return, dry return or vacuum return system. Use appropriate steam coil detail for wet/dry or vacuum return. Verify vacuum return has proper water seal or equalizing line and eliminate vacuum breaker.
    b. All coils shall be ARI certified.
    c. Steam supply to heating coils for air handling units shall not be tied into perimeter house steam heating system which may cycle on and off during the heating season. Check with M.I.T. personnel and connect to year round steam source. Provide pressure reducing station as required. Steam pressure to coils shall be minimum 10 psig.
11. Chilled Water Cooling Coils
    a. Size coils for (5) five foot maximum pressure drop and (16) degree water temperature rise. Multiple coils shall be used as required.
        1) West and main campus: 43 deg. F summer, 52 deg. F winter.
        2) East campus: 43 deg. F summer, 58 deg. F winter.
    a. All coils shall be ARI certified.
    b. Coil winterization: All coils shall be provided with a manual air drying method using 1-1/2-inch valve connection at coil inlet with three-inch duct, blastgate and flexible duct connected to fan discharge duct. Duct shall be connected to valve for manual air drying of the coil after the coil has been isolated and drained.
    c. Condensation drainage: Pipe to clear water drains, storm or grade to meet MWRA requirements.
12. Filters
    a. For labs, provide pre-filter bank and final-filter bank. Efficiencies shall be reviewed with M.I.T. Project Manager.
    b. Generally for offices, classrooms and dormitories, provide pre-filters and final-filters.
    c. V-bank arrangement should be used where possible and as required to increase pre-filter surface area and increase life (250 feet per minute maximum recommended velocity). Final-filters shall have maximum 500 feet per minute velocity.
    d. Provide differential pressure gauges across each filter bank with red flag indicator for filter change-out.
    e. Provide access doors on both sides of casing unless the filter compartment is a walk-in or the unit is small enough to be serviced from one side.
    f. Review other special filtrations requirements with M.I.T. Project Manager and end user.
13. Humidification: Typically not preferred. Special applications will require humidification. These shall be reviewed with MIT Project Manager and end user.
14. Heat Recovery: The merits of heat recovery shall be considered for 100 percent outdoor air applications where feasible and where required by Article 13 of the Massachusetts State Building Code. These shall be carefully studied and reviewed with MIT facilities staff. Use of heat recovery will be based on life cycle cost analysis.
15. Air Handling System Efficiency: The entire air handling system, including without limitation, air handlers, ductwork, coils, filters and other components must be designed for appropriate static pressures, optimum operating efficiency, and other considerations. The system designer must provide justification of design decisions through a detailed analysis submitted to MIT Project Manager for approval.

16. Starters, Variable Frequency Drives and Motors: Motors shall be premium efficiency conforming to NEMA Standard 31, MG1.31. Motors shall be suitable for use with variable frequency drives where applicable. Coordinate voltage and part winding start requirements with Electrical Engineer.
    a. Starters and variable frequency drives shall be specified to be furnished and installed under the electrical section except where they are part of packaged equipment.
    b. Generally, motors _ horsepower and above, shall be three-phase and motors below _ horsepower, shall be 120 volt single-phase.

Air Handling System Noise and Vibration

1. Carefully design the entire air handling system to minimize noise and vibration. Equipment larger than 5 HP shall have a vibration analysis performed and any corrective action taken as necessary.

Horizontal Propeller Unit Heaters

1. Louvers to provide four-way air diffusion.
2. Steam coil rated 150 psig. Steam inlet on top, condensate outlet on bottom.
3. OSHA fan guard.
4. Motor unit heater service with automatic reset inherent overload protection.
5. Internal vibration isolation.
6. Multi-speed motor with speed switch mounted on unit.

Fan Coils

1. Airtherm or approved equal.
2. Four-way adjustable discharge grille.
3. Three-speed motor with automatic reset inherent overload protection.
4. High capacity type 2 cooling coil.
5. Internal vibration isolation.
6. Motor cord quick disconnect and toggle operated fused disconnect switch.
7. Drain pan sufficient size to cover end pocket piping and control valve.
8. Vertical units and horizontal units in labs: integral mounted speed switch. Should not be user adjustable. Horizontal units in office: wall mounted speed switch, (user adjustable).
9. Provide auxiliary drain pain for units located above ceilings.
10. Size units at medium fan speed.
11. Low profile horizontal or vertical unit sizes range from 200 to 1200 CFM. These unit sizes shall not be larger than1,000 CFM nominal.
12. Size units for both summer load with 43 deg. F chilled water and winter load with 52 deg. F chilled water. Use 16 degree water temperature difference.
13. Where heating is required by fan coil unit, design for a 4-pipe cooling/heating system. Use of two-pipe changeover systems shall be evaluated and reviewed with M.I.T. Project Manager.
14. Larger fan coil air conditioning units may be used depending on load and application.
15. Review FCS-monitoring and control interface with M.I.T. Project Manager

Hot Water Reheat Coils

1. ARI certified.
2. Test at 315 psi under warm water conditions.
3. Where possible, design heating system for 140 deg. F or less.

VAV Terminal Units

1. Internally insulated, thermal and acoustic with mylar lining.

2. Damper air leakage shall not exceed 2 percent of rated air quantity at 1-inch static pressure. Casing leakage shall not exceed 2 percent of rated air quantity at 1-inch static pressure.
3. Provided with multi-port averaging differential pressure sensor.
4. Controls provided by Control Contractor, see Controls specification. ATC Contractor shall provide power wiring.
5. Sound data per ARI Standard 880, radiated and discharge NC less than 30 at 1-inch W.G.
6. Pressure independent.

Laboratory Airflow Control

1. Phoenix.
2. Control both supply and exhaust.
3. Hood face velocity controller to control exhaust.
4. Pressure independent valves for each fume hood on manifolded exhaust systems.
5. Control range 20-100% air flow.
6. Response time, one-second after reaching 90% of sash height or change in system static pressure.
7. Maintain room pressure using volumetric offset.
8. Provide fume hood monitor.
9. Air flow controller (supply and exhaust valves).
   a. Venturi control type.
   b. Pressure independent.
   c. Turn down 8 to 1 with +/-5% accuracy.
   d. Supply: 16-gauge aluminum assembly with 316 ss hardware.
   e. Fume hood and general exhaust shall have phenolic coating, 2 coatings. Shaft and hardware shall be 316 L. Shaft shall have 2 coats phenolic coating.
   f. Pneumatic operator, exhaust fail open, supply fail to minimum air flow.
   g. Valves shall be factory calibrated.
   h. Bolted gasket access doors shall be provided on inlet side of exhaust air valves serving fume hoods.
10. Provide one lab controller per lab. Electronic design to control supply, exhaust and reheat coils for air flow and room temperature control.
11. Coordinate interfacing with FCS control system for remote monitoring and alarming:
    a. Read exhaust air flow.
    b. Emergency override and flow alarm.
    c. Read sash position.
    d. Read room supply air.
12. Sound Attenuators: Review noise attenuation requirements with acoustical consultant.

Ductwork

1. Low Pressure Ductwork
   a. 1.0 inch negative or positive pressure.
   b. Room side of terminal units.
   c. Galvanized steel.
   d. Construction per SMACNA standards.
   e. Class B seal.
2. Fume Hood Exhaust, Snorkel Exhaust and Cabinet Exhaust
   a. Thermoplastic duct system, FM approved, fabricate per SMACNA standards.
   b. Consider stainless steel.
   c. 6.0 inch negative pressure.
   d. Leakage test.
3. Medium Pressure Ductwork
   a. Duct from AHU to terminal unit.
   b. 4.0 inch positive or negative pressure.

c. Construction per SMACNA standards.
d. Galvanized steel.
e. Leakage test.
f. Class A seal.

Flexible Duct Connections

1. Between fans and duct system.
2. Hard duct fume hood exhaust, no flexible connections.
3, Variable Volume Terminals: Generally thse shall be hard ducted where exposed.

Dampers and Splitters

1. Provide manual opposed blade volume damper in each supply, return and exhaust branch duct from associated main duct and in each run-out to supply or return diffuser or register.
2. Scavenger or snorkel exhaust use blast gate damper.

Fire Dampers

1. UL labeled in accordance with UL-555.
2. Install per SMACNA standards.
3. Blade completely out of air stream in the open position.
4. Provide access panel in duct and in ceiling or wall.
5. Use static type for systems that shut down on fire and dynamic type on systems that continue to operate.
6. Do not install on hazardous exhaust systems.

Belt Guards

1. Provide for all belt driven equipment, OSHA approved guards designed for easy removal and hinged arrangement.

Diffusers, Registers and Grilles

1. Provide vaned diffusers, registers and grilles to reduce drafts and slow outlet velocities.
2. For high volume areas, provide round or flat oval perforated duct diffusion equal to United type SP. Constructed and engineered in accordance with United Corporation's Engineering Report No. 153 "Designing SP Duct Diffuser Systems". Maximum pressure drop .1 inch static pressure. For user comfort avoid downward flow of air. In certain conditions the bottom portion of the perforated duct may require a sheet metal (shroud) blank-off piece.
3. Location and types of diffusers must be carefully determined to avoid drafts, fogging of windows, disruption of air flow at fume hoods, etc. In rooms without ceilings, consider use of lay-in panel type diffusers to avoid "dumping".

Exhaust Fans

1. AMCA certified for sound and air performance.
2. Statically and dynamically balanced to no greater than .1 inch/second. Vibration tested at factory.
3. Provide centrifugal, general purpose, Class II, fans for supply, exhaust and transfer with backward inclined or air foil type fan wheel.
4. Centrifugal used for fume hood exhaust installed indoors shall be up blast with weather hood and drain.
5. Tested per AMCA 210-85. Sound test per AMCA 300.
6. UL listed per UL 705.
7. Fans shall meet NFPA-45.
8. Spark resistant construction per AMCA "C" when appropriate.

Gravity Roof Ventilators

1. Spun aluminum with bird screen and insulated roof curb.

Motors, Drives and Starters

1. Premium efficiency motors, conform to utility company standards for rebate if available.
2. Starters and VFD's provided by electrical unless part of packaged equipment.

Variable Speed Controllers

1. Motors for VFD shall be VFD rated.
2. Provided under electrical section. Coordinate with electric design.
3. Do not use variable inlet fan vanes unless there is justication.

Access Panels and Doors in Ductwork

1. Access doors and panels must be appropriate size for intended purpose.
2. Show location and sizes of access doors and panels on Contract Documents and do not assume Contractor will provide the correct size or the correct locations.
3. Provide access doors and panels for all valves, dampers, fire dampers at both sides of booster coils, at VAV boxes, at all control devices and elsewhere needed.

Humidification Location

1. If humidification is used, locate downstream from the fan.

Acoustical Duct Lining

1. If at all possible, do not use duct lining anywhere on the air supply system. Use silencers or double wall ductwork constructed with a perforated steel liner to achieve sound attenuation.
2. If silencers will not achieve the desired result and the extent of double wall duct required is cost prohibitive, use flexible closed cell engineered polymer foam insulation duct lining. Emphasize compliance with the manufacturer's installation standards in the specification.

Insulation

1. Insulate ducts on the exterior for condensation control. Ductboard is more durable and neater in appearance than ductwrap. Do not use internal insulation on fans. If ductwork insulation is to be exposed, review the requirements, durability and appearance of externally mounted insulation with M.I.T. Project Manager and Architect.

Sound Attenuators

1. Schedule acoustic performance requirements.
2. Verify self-generated noise does not exceed noise criteria.
3. Test silencer per ASTM E477.
4. Attenuation material must be protected from erosion. Perforated covers should be used, but may not be adequate to prevent fibers from entering the air stream. Erosion coatings may not be long lasting and durable. Use mylar film for critical areas. Review special coatings which may be required for fume hood exhaust systems.

Pneumatic Dampers

Do not locate pneumatic damper operators and piping in unconditioned air stream.

Fan Drives

Adjustable speed sheaves are not permitted. Provide fixed sheaves once balancing is complete.

Green Design

1. Opportunities:
    - Fume Hood Design
    - Ventilation Design
    - Cleaning of Water Treatment Systems
    - CFC Reduction in HVAC and R Equipment
    - Renewable Energy: Solar or Wind Power
    - Elimination of HCFC's and Halons
    - Green Power: Purchased from "Green" Utilities
    - Thermal Comfort: Comply with ASHSRAE 55-1992
    - Thermal Comfort: Permanent Monitoring System
    - Heat Recovery
    - Economizers – Water/or air side
    - Efficient Control Schemes
    - VAV Systems
    - IAQ Monitoring – CO_2
    - Commissioning
    - Design for Ventilation Effectiveness
    - Model Design to Optimize Energy Consumption
2. Energy Conservation
    a. Since the conditioning and movement of air is a major component of energy conservation management systems, MIT has generally used off-hour set-back and shut-down techniques. HVAC energy conservation is closely related to MIT's Facility Control System. HVAC systems must be designed to permit transition from off-hour to peak-hour conditions within a reasonable period of time. It is expected that systems with proper capacity will have no problem with the transition from off-hour to peak-hour conditions.
        (1) Zoning: Zoning of building HVAC system into subsystems serving areas with common environmental and occupancy requirements is typically required. Give consideration to zoning techniques which accommodate individual after hour occupants with minimum operation of areas not in use. Buildings with fan coil units shall have those units controlled (on/off) in blocks by a time clock or FCS control point occupancy schedule. After hours occupant override shall be provided through occupied/unoccupied switch on thermostat.
        (2) Ventilation: Ventilation rates should be minimized, but always maintained within the acceptable parameters established by Massachusetts Building Code, ASHRAE, MIT Project Manager and building codes.
3. Review the impact of green design on indoor air quality.
4. Receive design imput and comments from the "Green Building Task Force"

Operations

1. Provide adequate space around equipment for maintenance.
2. Provide proper clearance for panels, tube pull, etc.
3. Lube oil lines for fans located outside unit 4.
4. For contaminiated exhaust place motors outside air stream.
5. Provide adequate valves, dampers, etc., to isolate equipment during maintenace.

Laboratory Services

(This Section to be Added)

Environmental Health and Safety Issues

1. Laboratories
   a. Adequate velocity across face of hoods.

(This Section to be Added)

Institute Spaces and Art, Architecture and Preservation

(This Section to be Added)

DESIGN REVIEW CHECKLIST

The Design Consultant is responsible for filling out and submitting this checklist at each phase of design as a guide for design review by M.I.T. Facilities.

SCHEMATIC DESIGN

A. ______ Submit bound copy of calculations for:

1. cooling loads
2. heating loads
3. ventilation loads
4. chilled water and steam
5. outside air
6. supply air
7. lab equipment cooling water loads

B. ______ Systems considered, i.e.:

1. all air
2. combination
3. type of heating system
4. energy recovery options
5. annual load profiles
6. submit bound copy of written narrative of systems proposed

C. ______ Obtain approval of design comfort level (heating and cooling operating standards) from M.I.T. Project Manager.

D. ______ Energy Analysis: A thorough energy analysis of the complete HVAC system includ ing associated electricity, chilled water, steam utilities is required for allprojects. Op portunities for life cycle cost savings must be identified and evaluated by the system designer and submitted to M.I.T. for review prior to design development drawings.

1. Cost Benefit Analysis:

   a. Heat Recovery
   b. Constant Air Volume versus Variable Air Volume

E. ______ The volume of ventilation and ventilation systems must be reviewed with M.I.T. Project Management and EMS during the design phase.

F. ______ If Central Plant Steam is used verify steam for Heat Generation and coordinate with M.I.T. Project Manager for existing conditions and typical standard details.

G. ______ Code, regulations and standards review.

H. ______ Identify major equipment.

I. ______ Identify space requirements.

Signature of Responsible Mechanical Engineer ________________________________

Dated ________________________________

DESIGN DEVELOPMENT

A. _____ Finalize system selection.

B. _____ Equipment scheduled (sizes), agree on manufacturers.

C. _____ Finalize space requirements and architectural coordination.

1. Major shaft size and location.
2. Louver size and location.
3. Mechanical room block layouts.

D. _____ Flow diagrams of major systems including quantities and pipe sizes..

E. _____ Controls description including diagrams.

F. _____ Engineering calculations (updated). Submit bound copy.

G. _____ Energy code compliance verification.

H. _____ Specifications. Submit bound copy.

Signature of Responsible Mechanical Engineer ________________________________

Dated ________________________________

CONSTRUCTION DOCUMENTS

A. GENERAL

1. _____ List of changes and and deviations from Design Development.

2. _____ Drawing List.

3. _____ Drawings agree with specifications.

4. _____ Drawings marked for Progress, GMP, Bid or Construction.

5. _____ Final drawings/prints sealed – embossed per State requirements.

6. _____ All HVAC components have been shown on the drawings.

7. _____ All existing and new work is clearly labeled.

B FLOW DIAGRAMS

1. _____ Diagrams depict engineering of the HVAC system.

2. _____ Arrangement of equipment is similar to actual conditions in a schematic format.

3. _____ All major equipment shown, identified and coordinated with scheduled sheets.

4. _____ Engineering complete. All calculations for pumps, fans, etc. complete and available for review.

5. _____ Flow rates, pressures, and consumption rates shown.

6. _____ Control valves and major isolation valves shown.

7. _____ Floor location and major section of building included in diagram.

C. FLOOR PLANS

1. _____ Spot check duct sizes and compare with static pressure calculation.

2. _____ Spot check air devices for

   a. Air flow
   b. Pressure drop
   c. Noise level
   d. Throw
   e. Neck velocity

3. _____ Major system components for face velocity and pressure drops against specific equipment.

4. _____ HVAC drawings for chilled water, steam or hot water supply to HVAC equipment.

5. _____ All areas heated, ventilated or air conditioned as required. Supply, return and exhaust air balance.

6. _____ Location of thermostats, humidistats, duct smoke detectors, and firestats.

7. _____ Access provided where needed.

   a. Controls
   b. Coils
   c. Fans
   d. Dampers
   e. Valves
   f. Filters

8. _____ Lines are heat traced where necessary.

9. _____ Cooling and Heating load calculations versus equipment sizing.

10. _____ Equipment and static pressure have been calculated.

11. _____ Check labels on all ductwork, piping, equipment etc.

12. _____ Spot check duct runs to be sure that the duct shown will fit into the available space and does not interfere with pipes, lights, or structural members. Routing conforms to accepted design practices.

13. _____ Spot check pipe runs to be sure that the pipe will fit into the available space and does not interfere with ducts, lights, or structural members. Routing conforms to accepted design practices.

14. _____ Check the piping system to see if adequate expansion loops and anchors have been provided and detailed.

15. _____ Check run outs to room terminal units to see if pipes clear beams and other obstructions.

16. _____ Check project plans to see if the location of all ducts and pipes have been indicated.

17. ____ Check the door schedule to see if all doors requiring ventilation openings have been adequately undercut or louvered or transfer ducts provided. Coordinate with Architect.

18. _____ Check the drawings to see that all room names and numbers and column numbers have been properly included.

19. _____ Check all ceilings to be sure that air outlets do not interfere with lights.

20. _____ Check headroom available for all ceiling hung units such as unit heaters.

21. _____ Check to be sure that all airflows show balance. Check room by room balance and check room totals against flow shown on air handling units and fans.

22. _____ Check to see if fire dampers, smoke dampers, and fire-smoke dampers have been shown in accordance with the local codes and ordinances, these are required in floors too.

23. _____ Check acoustical requirements of the project to see if all required sound traps have been provided to give the required attenuation of noise.

24. _____ Check locations of volume dampers.

25. _____ Spot check of piping: sizes, arrangement, fitting etc. versus pump calculations.

26. _____ All piping can be easily supported and all guides and anchors are specified and detailed.

D. MECHANICAL EQUIPMENT ROOM

1. _____ Equipment Location/Lay out allows for access and maintenance, coil removal, tube pulls, damper, valves, controls, etc.

2. _____ Coordinate floor drain location with plumbing for coils, plenums,

pumps.

3. _____ Drains and vents properly located.

4. _____ All equipment properly identified. Verify all equipment is scheduled on the schedule sheet.

5. _____ Flexible duct, vibration isolation and sound isolation connections are called for where needed (expansion joints, equipment on isolators).

6. _____ Piping unions at unit, thermometer wells, pressure gauges, trap drainage, and traps on cooling coil condensate drains.

7. _____ Outside air intake and exhaust opening sizes, considering economizer cycle if used. Proper velocity to prevent snow carryover. Height above ground and recessed from building wall to prevent show intrusion. Plenums should be drained.

8. _____ Be sure building service connections coordinate with HVAC equipment.

9. _____ Check to see if freeze protection has been provided for cooling coils, cooling tower sump, etc.

10. _____ Check to see if adequate combustion air openings have been provided for the boiler room, for boilers, hot water heaters and other fuel burning equipment.

11. _____ Check the flue size and height to see if adequate draft has been provided.

12. _____ Insulate ductwork between fans and condensate areas.

13. _____ Ascertain ceiling clearance in adjacent areas for duct connection between mechanical room and floor served.

14. _____ Provide at least one section of all mechanical rooms.

16. _____ Show control dampers.

17. _____ Check for proper ventilation of mechanical rooms.

E. SCHEDULE

1. _______ Check that all electrical data is complete and coordinated with electrical department.

2. _____ All equipment scheduled and properly labeled.

3. _____ Check calculations for all major equipment: AHU's, pumps,

chillers, expansion tanks, etc.

4. _____ Check equipment pressure ratings to verify it is adequate for the static height of building.

F. STANDARD DETAILS

1. _____ Only details that apply to the project.

2. _____ Details customized for this project.

3. _____ Are there schedules on the details and are the schedules complete.

4. _____ Custom AHU's are detailed with all components, dimensions, plan and elevation.

5. _____ Details are properly cross referenced on detail sheet and plans.

6. _____ Equipment hook-ups detailed but not dimensioned.

G. CONTROLS

1. _____ Electrical requirements coordinated with electrical department.

2. _____ All equipment covered under a sequence of operation.

3. _____ System operation for start-up, shutdown, summer, winter, and intermediate seasons. Reviewed for need of special equipment, dampers, heaters, etc.

4. _____ Review control points for adequacy of control and monitoring.

5. _____ Control points called out and adjustable.

Signature of Responsible Mechanical Engineer ____________________________________

Dated ____________________________________

END OF SECTION

TESTING, ADJUSTING, BALANCING & COMMISSIONING

1. **Preliminary Installation Tests:** The Construction Contractor and its subcontractors shall make the following preliminary mechanical system tests and obtain approval and acceptance of M.I.T. and the Project Engineer and Architect, if any.

   A. Certifications: Require the Contractor to provide test certifications showing the test has been made and is approved by local authorities and the M.I.T Project Manager.

2. **Soil, Waste and Vent System Testing:** Comply with requirements of City of Cambridge Plumbing Inspector.

3. **Down Spout and Rain Leader Testing:** Comply with requirements of City of Cambridge Plumbing Inspector.

4. **Fire Protection System [Sprinkler] Testing:** Comply with requirements of City of Cambridge Plumbing Inspector. Make hydrostatic pressure tests for 2 hours in compliance with NFPA Standard 13 [paragraph 1-11.2.1], in compliance with 780 CMR 1000.6 and 1004.8, and in compliance with 1987 BOCA 1004.8. Test at not less than 200 psi, except test at 50 psi higher than maximum design pressure when design pressure is greater than 150 psi. For occupied, sensitive areas [such as libraries, museums and computer rooms] make an air pressure test first before water testing.

5. **Gas System Testing:** Comply with requirements of City of Cambridge Plumbing Inspector.

6. **Compressed Air System Testing:** Make pneumatic pressure tests for 2 hours at not less than 150% of operating pressure, but never less than 50 psi.

7. **Steam, Condensate and Water Piping Testing:** Make hydrostatic pressure tests for 2 hours at not less than 150% of operating pressure, but never lass than 50 psi. For large projects, test system in sections – X-ray of welds where required by piping spec.

8. **Medium and High Pressure Ductwork Testing:** Test duct risers and branches individually with a blower, orifice section and U-tube gauge board. Isolate each riser and branch under test with seals, plugs and caps. Maintain 8" pressure with maximum loss of 1" pressure difference across the orifice plate. Repair leaks with loss of more than 1" and all noisy or whistling leaks and retest until accepted by M.I.T. Project Manager.

   A. Horizontal Mains: Test horizontal mains in the mechanical room after all risers have been accepted, after horizontal mains have been connected to the risers and before branches have been connected to the risers. Make tests as indicated above for duct risers and branches.

   B. Final Connections: Only after work has been tested and accepted, connect branches to the risers and begin insulation work

9. Other Specific Testing: Additional requirements for specific testing may be found in other guidelines. For X-ray testing of welded piping, see 15550, 15650. For vibration testing for systems larger than 5 Hp, see 15850.

10. Operating Tests and Balancing: M.I.T. may employ a separate contractor [Balancing Contractor] independent of contractors employed for other mechanical work on the project to test and balance all mechanical system piping and air handling systems. Discuss the particular project require-

ments with the M.I.T. Project Manager before developing these specifications.

A. Balancing Contractor's Responsibilities During Original Installation: The Balancing Contractor shall make regular visits to the job site during installation of mechanical systems to ensure that work is being installed in a manner and with accessories which will permit satisfactory balancing of the systems.

B. Balancing Contractor's Responsibilities During Pressure Testing: The Balancing Contractor shall observe pressure testing of medium and high pressure ductwork to the extent that the Balancing Contractor can ensure that the completed system will be sufficiently air tight to permit proper air balancing.

C. Notification Required: The Balancing Contractor shall immediately notify the M.I.T. Project Manager and the Architect in writing with specific information if the Balancing Contractor believes that additional accessories such as dampers and valves are necessary for proper balancing, and if the Balancing Contractor believes that any work is being installed in a manner, which adversely affects proper balancing.

D. Test Policies and Procedures: The Balancing Contractor employed by M.I.T. will make operation and balancing tests only after pressure tests and system cleaning is completed by the Project Contractor and its Mechanical Subcontractor. Make tests in the presence of M.I.T. Project Manager and Project Engineers and Architect. Make CFM and static pressure tests.

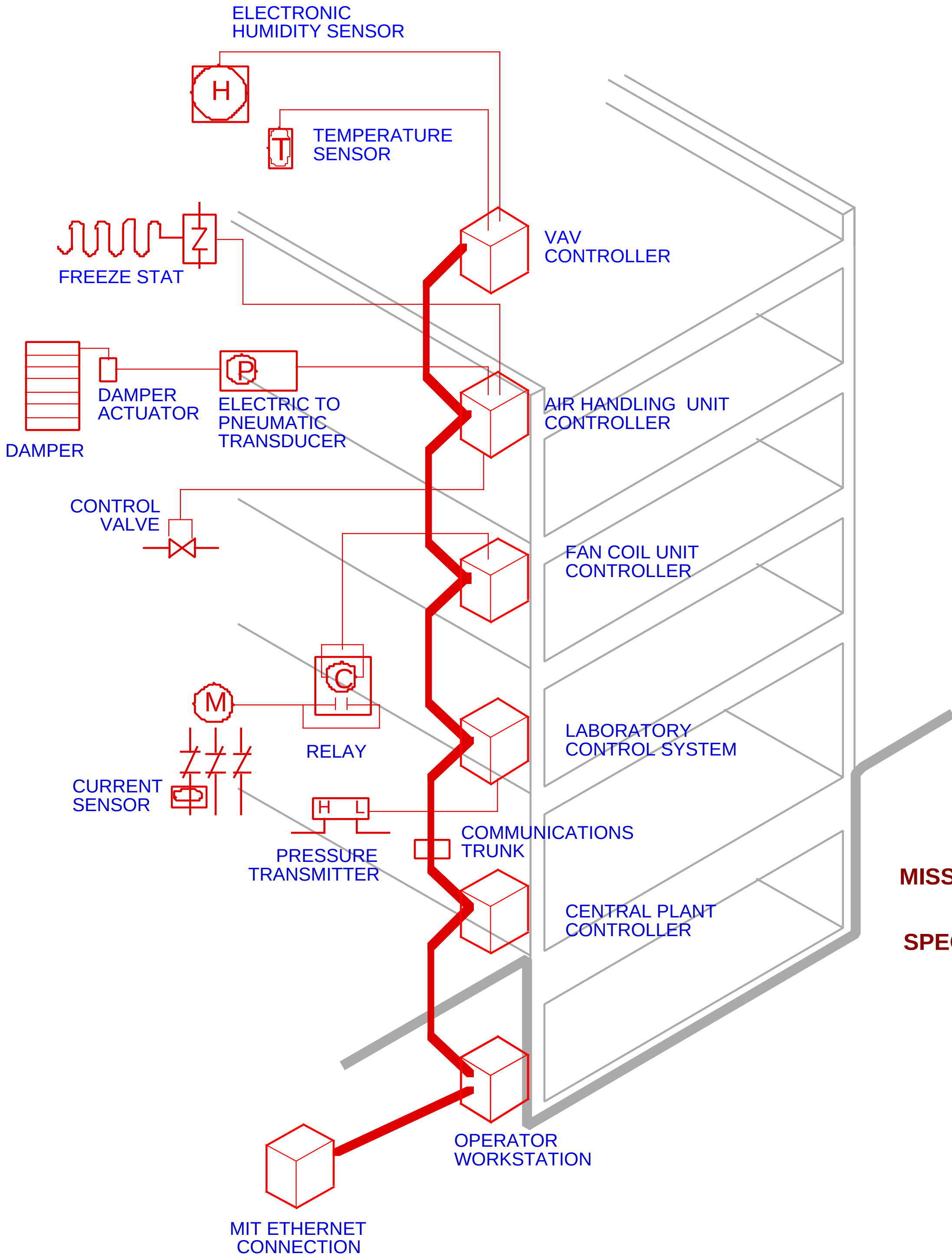
   1) Test Equipment: The Balancing Contractor shall provide all test equipment, gauges, instruments and personnel needed to properly complete the tests performed by the Balancing Contractor.

   2) Construction Contractor's Responsibilities: The Construction Contractor and its subcontractors shall cooperate with the Balancing Contractor and shall make all necessary adjustments as recommended by the Balancing Contractor. At no additional cost to M.I.T., the Construction Contractor and its subcontractors shall adjust or replace all impellers, pulleys, sheaves, belts, dampers and other work, and shall add dampers as needed for correct system operation and balance. After balancing is complete, the Construction Contractor and its subcontractors shall replace adjustable sheaves with fixed sheaves and check total system airflow to be sure it remains within specification.

   3) Test Evaluation and Acceptance: The Balancing Contractor shall provide a detailed Balancing Report. The Balancing Report shall not be a copy of the design documents. The Balancing Report shall be a new report with tables having columns for Room Name and Number, Design Requirement, Measured Value and Deviation. The Balancing Contractor shall also provide typewritten opinions and evaluation as to whether the installed systems meet design requirements. Acceptance and approval of the installed work, however, shall remain with the Project Engineer, Project Architect and M.I.T. Project Manager, and not the Balancing Contractor.

E. Acceptance Criteria: To be acceptable, design requirements must be met within +/-10%. In addition to meeting design requirements, the installed work shall operate with the least possible and no objectionable noise or vibration. Quiet and vibration free operation is a Contract requirement. Work, which does not meet this requirement, shall be repaired or replaced at no additional cost to M.I.T.

   1) Acceptance by Authorities: A Contract requirement shall be to provide systems, which are acceptable to authorities having jurisdiction. Work, which does not meet this requirement, shall be repaired or replaced at no additional cost to M.I.T.



15 FACILITY CONTROL STYSTEM

MIT FACILITY CONTROL SYSTEM

MIT Department of FACILITIES
BUILDING SYSTEMS
DESIGN HANDBOOK

ver. 1.1

Mission Statement

1. The purpose of this document is to provide direction to the design engineer relative to the minimum requirements of control system design. For new buildings the latest revision of the MIT facility control system master specification shall be used by all design engineers as the base document for creating all new building facility control system specifications.

2. Equipment location and housing should provide easy access maintenance, repair, replacement and day to day operation.

3. As an institute of technology MIT is particularly receptive to control system design innovations which reduce installation and operating cost and maintenance and improve safety.

4. Control system designs and installations at MIT should provide an acceptable level of indoor air quality and comfort, minimize energy use and install materials that are safe for the environment.

5. It is not the intent of this code to limit designs or creativity, but to provide guidelines for consultants and contractors to follow and stimulate discussions, questions and the exchange of information.

6. Design teams should always review plans for future expansion before completing the design for new building systems to determine if additional capacity or infrastructure should be installed.

7. Control systems selected should have a long record of support and compatibility with older generations of controls.

8. MIT will hold contractors and engineers responsible for the design, installation and demonstration of operation of all systems to an independent commissioning authority.

Top Ten List of Common Control System Design Issues

1. Verify that all contractor responsibilities are clearly outlined for all systems
    a. Power wiring for VAV boxes
    b. Smoke detector installation
    c. Smoke detector power
    d. Smoke detector interlock wiring to air handling unit
    e. Smoke detector wiring to fire system
    f. Boiler safety wiring
    g. Chiller safety wiring
    h. Damper and valve installation
    i. Freezestat interlock wiring
    j. Cooperation with test and balance contractor
    k. Commissioning
    l. Training
    m. Operation and maintenance manuals
    n. Submittal requirements

2. Identify controllers that will require emergency power and UPS backup systems to continue operation during smoke evacuation or other emergency modes.

3. Make sure that all installed equipment meets the MIT labeling requirements outlined in this document in the installation section.

4. Verify that sequence of operation submitted by the controls contractor meets the intent of design documents.

5. Double check valve and damper sizing to insure that they are of adequate size to handle fluid capacity yet small enough to provide controllability.

6. Coil valves on OA units shall be Fail Open. This includes both heating and cooling coils

7. Always create an interlock with the makeup air handling unit for each classroom or office so that when a room is occupied the associated makeup air unit will run.

Special MIT Design Criteria

A. General

i. Unless otherwise specified **by MIT** for the particular instance, Each system (AHU, VAV Box, FCU, Chiller, etc.) shall have its own dedicated controller.

ii. Terminal Units (DDC controlled)

1. Where one terminal unit feeds several rooms each room will have a temperature sensor. Where several terminal units feed one room there will be a single temperature sensor which feeds all terminal units for the room.
2. Where a space utilizes terminal units and perimeter radiation a single analog output will feed the terminal unit reheat valve and the radiation control valve in parallel. The spring ranges will be selected to lead with the perimeter radiation and follow with the terminal unit reheat valve.
3. Where a space utilizes terminal units and fan coil units a single pneumatic thermostat will regulate fan coil valves. A digital output from the DDC controller will control a relay to start/stop the fan coil units. Each space will have a local override switch to bring on the fan coil units for that space only.
4. Classrooms and offices will employ sensors with temperature sensing and override buttons for after hours occupancy, occupant setpoint adjustment, and a communication port for a field service device.
5. Common areas and utility spaces will employ sensors with temperature sensing and a communication port for a field service device.
6. Each room shall have an occupied/unoccupied schedule installed by the contractor. MIT will provide schedule. Design engineer and MIT will specify setup and setback temperature setpoints.

B. Design Strategy for Variable Air Volume Boxes

i. All VAV boxes shall be pressure independent.

ii. One DDC shall be provided for each VAV box.

iii. Each VAV box shall have a heating and cooling setpoint with a deadband between. When the room temperature is below the heating setpoint the box will remain in the minimum position and the heat (reheat and/or radiation) will be on. When the room temperature rises above the heating setpoint and is below the cooling setpoint the box will remain in the minimum position and the heating valve will be closed. As the room temperature rises above the cooling setpoint the box will modulate from minimum to maximum programmed airflow and the heating valve will remain closed.

1. In cases where there is a reheat coil and radiation in the same room the control routine shall lead with the perimeter radiation and follow with the terminal unit reheat valve.

iv. Room thermostat shall have adjustment slider with a range that is software adjustable. The room setpoint will be in the middle of the heating and cooling setpoints. When adjusted it will bias the heating and cooling setpoints. Unoccupied heating and cooling setpoints shall also be determined and programmed during startup of the control system.

v. All room thermostats shall have a temporary occupancy pushbutton that will cause the box to go from unoccupied to occupied mode when pressed. The time shall be adjustable in software from 0 to 4 hours.

vi. See laboratories section for special requirements.

C. Design Strategy for Fan Coil Units

i. Chilled water valve must be software interlocked to close when the unit is off. This requires a current sensor input from the fan on all units.

ii. The speed switches for office units will be mounted on the wall next to temperature sensor.

iii. The speed switches for common area units and labs will be unit mounted.

iv. Coil valves shall be Landis & Steafa 0-10V VVI/VVG Series with SQS65 non spring return actuators or equivalent.

D. Design Strategy for Air handling Units

i. All coil valves on OA units (100% or economizer) shall fail open. This includes heating and cooling valves.

ii. Freezestats are to be located directly following the preheat coil and both hardwired to shut down and fan and alarm at the BAS below 38Deg.F (Adj.) The BAS alarm shall be a critical alarm.

iii. Valves 3" and above shall be pneumatic. If 2 _" or below, select most cost effective for project.

iv. Damper actuators shall be the same actuation as selected for valves.

v. Operation of air handling unit shall be linked through software to the schedule of the rooms that it serves.

E. Design Strategy for Chiller plants

i.

F. Design Strategy for Laboratories

i.

G. Software Design Standards

i. General

1. All relevant graphics, help files, and database additions shall be online before a mechanical system is put into service.
2. MIT firewall security requirements
   a.
3. Web access requirements
   a.

ii. Database

1. Names will comply with pilot project contract specifications. Submit for review and editing all object names for DDC controllers, programs, points, schedules, and alarms to MIT's FCS project engineer.
2. All analog input points shall be configured with non-zero threshold values.
3. Define the following user attributes for the input/output points described:
   a. All inputs and outputs will have a LOCATION attribute where location information is to be stored. This attribute need not be filled in where the location is obvious.
   b. Duct pressure sensor should have floor and room number or point of reference such as a stairwell or column.
   c. Motor starting outputs should have where the equipment is located.
   d. Motor current inputs should have locations such as "MCC" or "Pump Starter".

e. Discharge air temperature sensor located in the unit needs no further information.
f. All digital output points will contain a PM NUMBER attribute where MIT will enter preventative maintenance index numbers for equipment.

iii. Graphics

1. Submit for review and editing all graphics to MIT's FCS project engineer.
2. Provide bold headings with the system name and location below the heading.
3. Graphics for identical systems are to be identical.
4. Place button controls at the bottom of the graphic.
5. Supply graphics as follows:
    a. One building riser:
    b. The building riser will show all floors in the building.
    c. Each system will be represented by an icon with the system name, shown on the floor where the system is located. The system icons are to be aligned vertically so that the user viewing the riser graphics sees a column of system icons and names.
    d. From the building riser the user may select one of the following:
    e. View a floorplan
    f. View a system schematic
    g. Return to campus map
6. One floorplan per floor:
    a. The floorplan graphic will show room numbers and functions
    b. Current values of any room sensors such as temperature, humidity, and flow will appear in the appropriate rooms.
    c. Show what mechanical system provides heating and cooling to the room.
7. From the floorplan the user may select one of the following:
    a. View a system schematic by selecting room
    b. Return to building riser
    c. Return to campus map
8. One system schematic per controlled system:
    a. The system schematic will show all associated input/output devices and their current values by displaying the VALUE attribute.
    b. Values of related key points in other systems will also show on the graphic. For example, a graphic showing a terminal unit with a reheat valve will show discharge temperature of the associated air handler and the supply temperature of the associated converter.
    c. For all analog outputs provide a slider control scaled to show percent open and corresponding control value in volts, milliamps, or pressure.
9. From the system schematic the user may select one of the following:
    a. Override the value of any input/output point to a desired state
    b. Adjust setpoints, control loop gains, and other parameters.
    c. View a related system schematic.
    d. View the sequence of operations.
    e. View the time of day schedule.
    f. Return to floorplan.

g. Return to building riser.
h. Return to campus map.

10. One controller type:
    a. The controller type will show the controller layout, point types, and capacities. This will include how many inputs, outputs, and expansion modules.

iv. Help Files

1. Supply sequence of operations help files for any new system accessible from system schematic graphics.
2. Supply typical program files with comments explaining the purpose of any variables and program logic not apparent upon inspection.

v.Program Files

1. Submit for review and editing all program files to MIT's FCS project engineer.
2. Programs for identical systems are to be identical.
3. Provide a differential for any points which cause toggling to avoid short cycling equipment.
4. Add emergency lines with appropriate error handling routines to prevent errors from disabling programs where possible and where necessary.

vi. Alarms

1. Provide suitable delays to avoid nuisance alarms.
2. After starting a system provide a 60 second delay before evaluating alarm conditions.
3. Provide a status alarm for each piece of equipment that is started and stopped (fan, pump, etc.). The status and start/stop points shall be linked so that if the state of both points does not match after a specified time delay an alarm will be displayed.
4. Provide an alarm for all room temperature sensors that is linked to either the fan running or occupied/unoccupied mode. Alarms shall have built-in adjustable differential and adjustable time delay.
5. Provide an alarm for temperatures that are out of range when equipment is not running. For example, if an air handling unit is off and the mixed air temperature is 170° F.
    a. The alarm indicates failure of a controlled device.
    b. The alarm indicates failure of a sensor.

vii. Schedules

1. The following applies unless the sequence of operations provided with the job specifications indicates otherwise.
2. For 24 hour, 365 day systems no schedule will be provided.
3. For systems that turn on and off based on time:
    a. Provide weekly schedule for occupancy Monday – Friday, 8:00am – 6:00pm.
        i. The schedule name will provide the building and system name.
        ii. The holiday schedule will be the MIT holiday schedule located in the root directory.

Installation Practices

A. Wiring

a. All interlocking, wiring and installation of control devices associated with Chiller, Boilers, Cooling Tower Basins shall be provided and installed by the controls contractor unless other arrangements have been made with MIT.

b. All Field Interface Panels (FIPs) containing electric or electronic devices shall be properly grounded.

c. All DDC controllers shall have a dedicated 20 amp circuit. Where convenient more than one controller may be l%d from the same 20 amp circuit.

d. DDC controller outputs shall be wired normally closed for all equipment with status inputs. Outputs shall be wired normally open for all equipment without status inputs.

e. All DDC controller input/output device wiring is to be run in metallic raceway with the following exceptions:

   i. Suspended Ceilings – If such ceiling is a return or supply plenum the cable shall be plenum rated.

   ii. Chases

   iii. Junction Boxes – Mounted within five feet of the device. BX or similar may be used between device and junction box.

f. In such cases where the cable is in chases or ceilings it shall be run neatly, secured to insulated pipes or other smooth surfaces, free from danger of sharp edges or exposure to electrical wires or contact with pipes carrying steam or steam condensate.

g. All devices utilizing modular type connectors will utilize factory fabricated cables or a combination of factory fabricated cables and terminal blocks. Field fabrication of modular plug terminated cables is not acceptable.

h. Any fittings, junction boxes, or raceway installed outside will be rated for outside use.

i. All threaded connectors are to be fitted with plastic bushings

j. Any raceway, trough, or junction box containing input/output wiring and/or communications cables shall be dedicated for such use, containing no conductors 40 volts or higher.

k. Conductors carrying 40 volts or higher will not be installed in a FIP unless required for the equipment therein.

l. FIP doors, all covers for junction boxes, and L-Bs containing input/output wiring and/or communications cables are to be painted with yellow enamel.

m. All DDC controller power supplies are to be equipped with a service switch on the line voltage side of the power supply. In addition, if the power supply feeds more than one DDC controller each DDC controller shall be equipped with a service switch.

n. The inputs and outputs on all DDC controllers with similar input/output requirements are to be wired identically in the same order. For example, if the room temperature sensor is wired to channel two on a terminal unit controller then all room temperature sensors will be wired to channel two on their terminal unit controllers.

B. Pneumatic Tubing

a. Use only hard-drawn copper tubing or Polyflo or similar plastic tubing.

b. All plastic tubing must be in a trough or raceway except the last three feet of a run to a field device.

c. All entrances of plastic tubing into an enclosure or trough shall be equipped with bushings to protect the tubing from damage.

d. All couplings, tees, and other fittings shall be in junction boxes or FIPs except for the fitting connecting the tubing to the field device.

e. All entrances of copper tubing into FIPs shall be through bulk-head fittings.

C. Labeling
   a. Labels shall be placed on the outside of all FIPs with the appropriate building and system names. There shall be separate labels for each system. An additional label for each DDC controller will contain information describing the DDC controller's network address. All such labels are to be plastic with white lettering on a blue background.
   b. Relays, current transducers, I/Ps, P/Is, and other input/output devices are to be labeled with abbreviation for the system and device name. For example, the label for W70 Chiller Converter Condenser Pump output would read "ChlCV CndPmp". Such labels are to be plastic with white lettering on a blue background. If the conductors are carrying 48 volts or higher such labels are to plastic with white lettering on a red background.
      i. All wires connecting input/output devices shall be labeled at both ends of the cable with printed adhesive labels containing the abbreviations describing the system, device name, and channel number. For example, the cable to E51 AH1 Steam Valve on Channel 12 would read "AH1 StmV 12".

D. Communications
   a. MIT will provide drops with modular connectors at the required locations for all devices requiring an Ethernet connection. The contractor will make the final connection to the equipment's communication port.
   b. Whenever possible and with MIT's prior approval, existing media provided by MIT will be utilized such as spare fibers, point-point telephone circuits, coaxial risers, etc.
   c. All communication devices such as routers, modems, and drivers shall be mounted at the equipment location. No such equipment will be mounted in telephone closets. All such equipment shall be securely installed in enclosures and labeled.

E. Field Interface Panel Mounting
   a. All FIPs are to be mounted on vibration free surfaces, unistrut or similar.
   b. All FIPs shall be mounted so that their doors are fully operable and so as not to obstruct access to any existing equipment.
   c. FIP mounting height shall be such that any person of average height will find the FIP serviceable and any diagnostic lights visible without requiring the person to bend or use a ladder.
   d. The FIP mounting location shall be chosen to minimize exposure to excessive vibration, EMI, dust, steam, water, or any other factors that may damage or impair the operation of the equipment contained therein.
   e. All FIPs will be in a locking enclosure keyed alike.
   f. All FIP doors shall be equipped with brackets for holding drawings and other documentation.

F. Field Device Installation
   a. Equipment Status
      i. Detection of equipment operation shall be accomplished by sensing current of the equipment motor, as opposed to flow switches, pressure sensors, or other means unless specifically called for.
      ii. All current sensing devices are to be securely mounted in motor control centers or starter cabinets so any indicating lights and adjustments are facing out.
   b. Temperature Sensors
      i. All temperature sensors are to be mounted such that they are free from any influence that may cause inaccurate readings such as being mounted in a stagnant air pocket

or being mounted near an exhaust vent or near doorways.

ii. Outside air sensors are to be equipped with solar radiation shields. They shall be equipped with surge suppression as needed to protect the associated DDC controller from damage by lightning.

c. Freezestats

i. The freezestat shall be serpentined across the discharge face of the preheat coil. Sensor shall be located before the cooling coil. In situations where coils are butted against each other, mechanical contractor must pull the preheat coil so the sensor can be installed.

Products and Materials

A. General
   a. Typically, the BAS Contractor shall furnish all control valves, sensor wells, flow meters and other similar equipment for installation by the Mechanical Contractor.
   b. Typically, the BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:
      i. Automatic control dampers
      ii. Fire/smoke dampers
      iii. Access doors for servicing of control equipment.
      iv. Blank-off plates for dampers that are smaller than duct size.
      v. Sheet metal baffle plates to eliminate stratification.
   c. Typically, the Electrical Contractor shall provide:
      i. VFD's
      ii. All power wiring to motors and mechanical equipment
      iii. Furnish smoke detectors and wire to the building fire alarm system. HVAC Contractor to mount devices. BAS Contractor to hardwire to fan shut down.
   d. Typically, the BAS Contractor shall provide:
      i. All power wiring to BAS panels
      ii. All power to BAS supplied end devices
      iii. All power wiring to all smoke damper actuators for smoke control sequence

B. DDC Sensors & Transducers
   a. Temperature Sensors – Space, Duct, and Immersion
      i. All temperature devices shall use precision thermistors accurate to +/- 1 degree F over a range of –30 to 230 degrees F. Space temperature sensors shall be accurate to +/- .37 degrees F over a range of 40 to 100 degrees F.
      ii. Standard space sensors shall be available in an off white enclosure for mounting on a standard electrical box.
      iii. Where manual overrides are required, the sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
      iv. Where a local display is specified, the sensor shall incorporate either an LED or LCD display for viewing the space temperature, setpoint and other operator selectable parameters. Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.
      v. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Probe style duct sensors are useable in air handling applications where the coil or duct area is less than 14 square feet.
      vi. Averaging sensors shall be employed in ducts which are larger than 14 square feet. The averaging sensor tube must contain at least one thermistor for every 3 feet, with a minimum tube length of 12 feet.

      vii. Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.
      viii. A pneumatic signal shall not be allowed for sensing temperature.

   b. Humidity Sensors
      i. Humidity devices shall be accurate to +/- 5% at full scale for space and +/- 3% for duct and outside air applications.

c. Pressure Sensors
   i. Air pressure measurements in the range of 0 to 10” water column will be accurate to +/- 1% using a solid-state sensing element. Pressure sensor shall be Modus series T30 or equivalent.
   ii. Differential pressure measurements of liquids or gases shall be accurate to =/- 0.5% of range. The housing shall be Nema 4 rated. Differential Pressure sensor shall be Robertson Halpern 260C Series or equivalent.

d. Current Sensors
   i. Current status sensors shall be used to monitor fans, pumps, motors and electrical loads. Current sensors shall be available in solid and split core models, and output an analog signal to the automation system. Acceptable manufacturer is Veris or approved equal.

e. Electric/Pneumatic Transducers
   i. Electric to pneumatic transducers shall operate from an analog signal. E/P transducers shall be rated for 0 - 20 psi operation and accurate to 2% of full scale. E/P transducers shall have a maximum air consumption of 100 SCIM.
   ii. E/P transducers shall be mounted separately in a field interface panel with the SCX920 controller or field mounted on VAV boxes for pneumatic radiation control. Panel mounted transducers shall be Sensycon fix span DIN rail Mounted or approved equal.

f. Electric/Pneumatic Solenoid Valves
   i. Electric solenoid operated pneumatic valves (EP’s) shall have a three port operation: common, normally open and normally closed.
   ii. They shall be rated for 50 psig when used for 25 psig or less applications, or rated for 150 psig when used for 100 psig or less applications.
   iii. The coils shall be equipped with transient suppression devices to limit transients to 150 percent of the rated coil voltage.

g. Relays
   i. Whenever the application permits use IDEC Corporation RH2B series relays or equivalent.
   ii. All relays are to be equipped with a status LED.

   iii. All relays being used for purposes other than starting and stopping motor driven equipment are to be equipped with a built-in check button for simulating energizing of the relay.
   iv. All relay bases are to be rail mounted.

h. I/P Transducers
   i. All I/P transducers shall be manufactured by Sensycon in either of the following configurations:
   ii. Model 22/0716 mounted on G-type DIN rail.
   iii. Manifold mounted HVAC model mounted on Sensycon manifold board.
   iv. All I/P transducers are to be fed 20 PSIG main air filtered to 25 microns, one filter per FIP with gauged output.
   v. All I/P transducer output signal ports are to be equipped with a barbed gauge tee, Honeywell part number MJP1604BT or equivalent and analog gauge reading 0-30 PSIG.

C. Control Valves – Water System

a. Valves Associated with Reheat and FCU Coils shall be Landis & Steafa VVG/VVI Series with SQS65 0-10V Actuators or equivalent.
b. Valves associated with HW Radiation shall be Landis & Steafa VVI Series with SQS82 Tri-State Actuators or equivalent.
c. Valves 3" and Larger Shall be Pneumatically Actuated. Valves shall be manufactured by Landis & Steafa or approved equal.
d. Valves 2 _" and smaller shall be electronically or Pneumatically Actuated. Valves shall be manufactured by Landis & Steafa or approved equal.
e. Coil valves on OA units (economizer and 100% OA units) shall be Fail Open. This includes both heating and cooling coils

D. Dampers

a. Automatic dampers, furnished by the Building Automation Contractor shall be single or multiple blade as required. Dampers are to be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.
b. Damper frames are to be constructed of 13 gauge galvanized sheet steel mechanically joined with linkage concealed in the side channel to eliminate noise as friction. Compressible spring stainless steel side seals, and acetal or bronze bearings shall also be provided.
c. Damper blade width shall not exceed eight inches. Seals and 3/8 inch square steel zinc plated pins are required. Blade rotation is to be parallel or opposed as shown on the schedules.
d. For high performance applications, control dampers will meet or exceed the UL Class I leakage rating.
e. Control and smoke dampers shall be Ruskin or approved equal
f. Provide opposed blade dampers for modulating applications and parallel blade for two position control.

E. Damper Actuators

a. Electronic Actuators
    i. The actuator shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage.
    ii. The actuator shall have electronic overload circuitry to prevent damage.
    iii. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.
    iv. Non-spring return actuators shall have an external manual gear release to allow positioning of the damper when the actuator is not powered.
b. Pneumatic Actuators
    i. Shall be of the synthetic elastomer diaphragm piston type and shall be fully proportioning unless otherwise specified.
    ii. They shall have full metal bodies and utilize replaceable diaphragms.
    iii. Damper actuators on large sections of modulating dampers (>25 sq.ft.) or high face velocity applications (such as fan inlet vanes) shall be equipped with pilot positioners to provide repeatability and quick response.

F. Thermostats

a. Pneumatic Thermostats
    i. Provide 2 pipe, non-bleed or "relay" type design, fully proportional with adjustable throttling range and tamper-proof locking settings.

ii. Provide single or dual temperature, direct or reverse acting thermostats as specified for sequence of operation.

b. Electric Thermostats
   i. Provide a low voltage thermostat for control of single zone heating and air conditioning equipment as specified in the sequence of operation.
   ii. Electric thermostats shall include a display of the current space temperature as well as a mechanism for adjusting the setpoint locally.

G. Smoke Detectors
   a. Air duct smoke detectors shall be by Air Products & Controls or approved equal. The detectors shall operate at air velocities from 300 feet per minute to 4000 feet per minute.
   b. The smoke detector shall utilize a photoelectric detector head.
   c. The housing shall permit mechanical installation without removal of the detector cover.
   d. The detectors shall be listed by Underwrites Laboratories and meet the requirements of U.L. 268A.

H. Airflow Measuring Stations
   a. Air Flow Stations shall be duct traverse type as manufactured by Brandt Industries or similar.
   b. Air flow measurement shall be via Modus 1% DP sensor, or equal, sized for CFM volume range.

I. Air Compressor Equipment
   a. The instrument air supply station shall ensure a constant supply of clean, dry control air to the pneumatic control system.

J. Sump Level Switch
   a. The level switch shall have (2) activation points for sump level alarm.
   b. Level switch shall be manufactured by GEMS

K. Freezestat
   a. The freezestat shall be Penn A70 autoreset series.
   b. Freeezestat shall be hardwire interlocked to shut down fan below 38Deg.F (Adj.)
   c. The freezestat shall be serpentined across the discharge face of the preheat coil. Sensor shall be located before the cooling coil. In situations where coils are butted against each other, mechanical contractor must pull the preheat coil so the sensor can be installed.
   d. There shall be 1 linear foot of freezestat for every 4 Sq.Ft of coil face.

Green Design

Opportunities
Automatic control of windows and or blinds
Automate control of rain water storage and distribution systems

Energy Conservation
Install motion detectors for lighting and HVAC for each room
Schedule occupancy for each room
Install temperature sensors with pushbuttons for extended occupancy
Chilled water temperature reset
Condenser water temperature reset
Demand limiting
Optimum start/stop
Hot water temperature reset
- Radiation loop
- Reheat loop

Operations

Laboratory Services

A. Laboratories
   1. Phoenix MIX cards shall be installed in the BAS interface panel.
   2. All wiring and Pneumatic air shall be by the BAS subcontractor
   3. The speed switches for common area units and labs will be unit mounted.
   4. 100% of all systems will be commissioned

Environmental Health and Safety Issues

Design Review Checklist for Control Systems

Schematic Design

Design Development

Construction Documents

1. _____ Coordinate electrical requirements with electrical department.
2. _____ All equipment covered under a sequence of operation.
3. _____ Review system operation for startup, shutdown, summer, winter and intermediate seasons.
4. _____ Review for need of special equipment, dampers, heaters, etc.
5. _____ Control points reviewed for adequacy of control and monitoring.
6. _____ Control points called out and adjustable.
7. _____ Each submittal includes an alarm matrix for all project alarms.
8. _____ All submittals have been reviewed by both the CA and Design engineer.
9. _____ Equipment cuts are clearly marked with exact part numbers being proposed for the project.
10. _____ Complete recommended spare parts inventory list has been included with the lead time and expected frequency of use of each part clearly identified.
11. _____ Following project completion and testing, the BAS contractor will submit as-built drawings reflecting the exact installation of the system. The as-built documentation shall also include a copy of all application software both in written form and on diskette.
12. _____ All shop drawings shall be prepared in Visio Professional or AutoCAD software. Inaddition to the drawings, the Contractor shall furnish a diskette containing the identical information. Drawings shall be B size or larger.
13. _____ Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typicals will be allowed where appropriate.

14 _____ Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and air flow station schedules shall indicate size, configuration, capacity and location of all equipment.

15. _____ Software submittals shall contain narrative descriptions of sequences of operation, point lists, and a complete description in matrix format of the configured alarms/alarm levels to be furnished with the workstation software. Information shall be bound or in a three ring binder with an index and tabs.

16. _____ Submit five (5) copies of submittal data and shop drawings simultaneously to MIT's project coordinator and the Engineer for review prior to ordering or fabrication of the equipment.

17.______ The Engineer will make corrections to submittals, if required, and return to the Contractor. The Contractor will then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.

18. ______ Submit for review and editing all object names for DDC controllers, programs, points, schedules, and alarms to MIT's FCS project engineer.

19.______ Submit for review and editing all graphics to MIT's FCS project engineer.

20.______ Submit for review and editing all program files to MIT's FCS project engineer

Signature of Responsible Engineer___________________________________Date ________________

DIVISION 16 - Electrical

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ELECTRICAL

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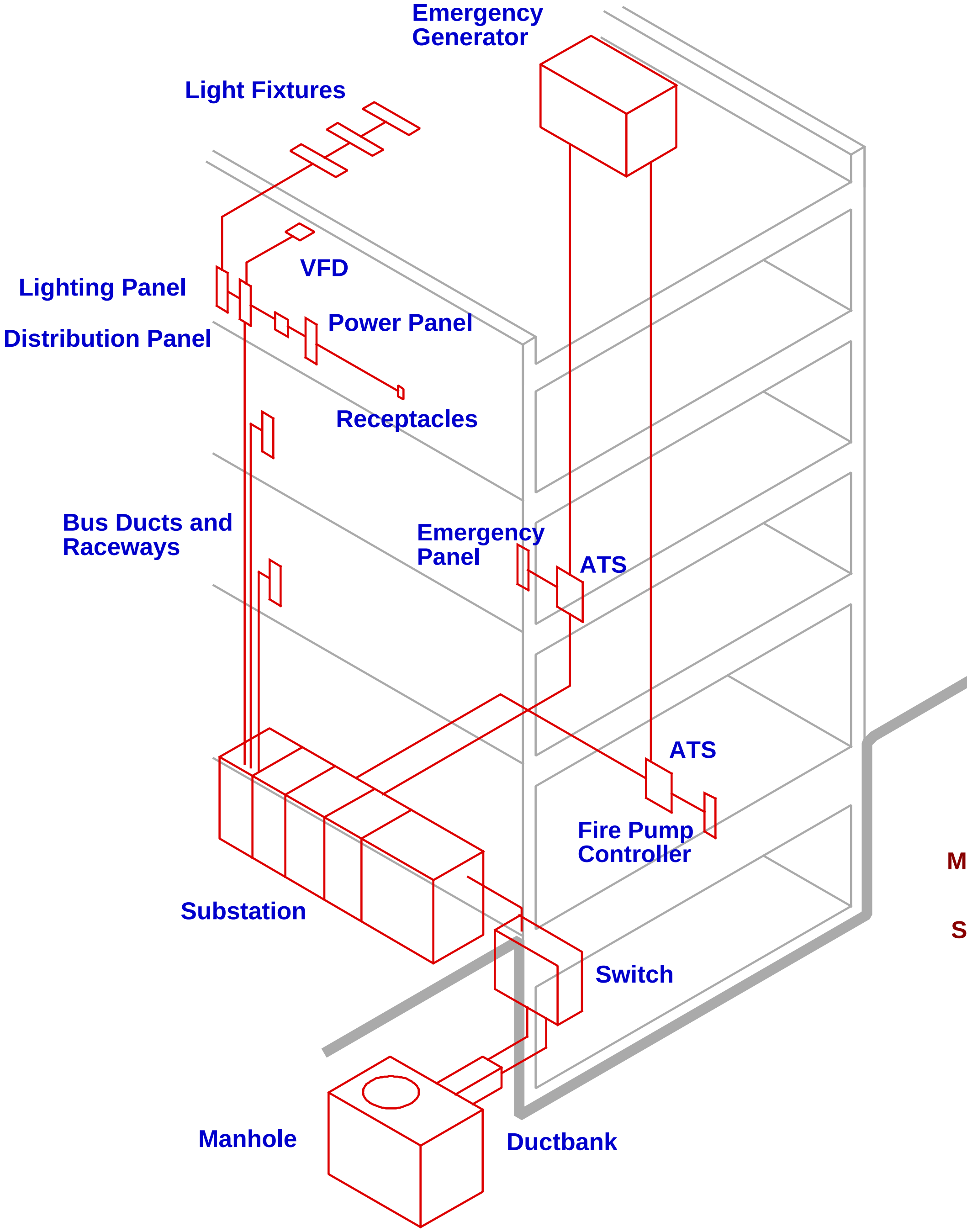
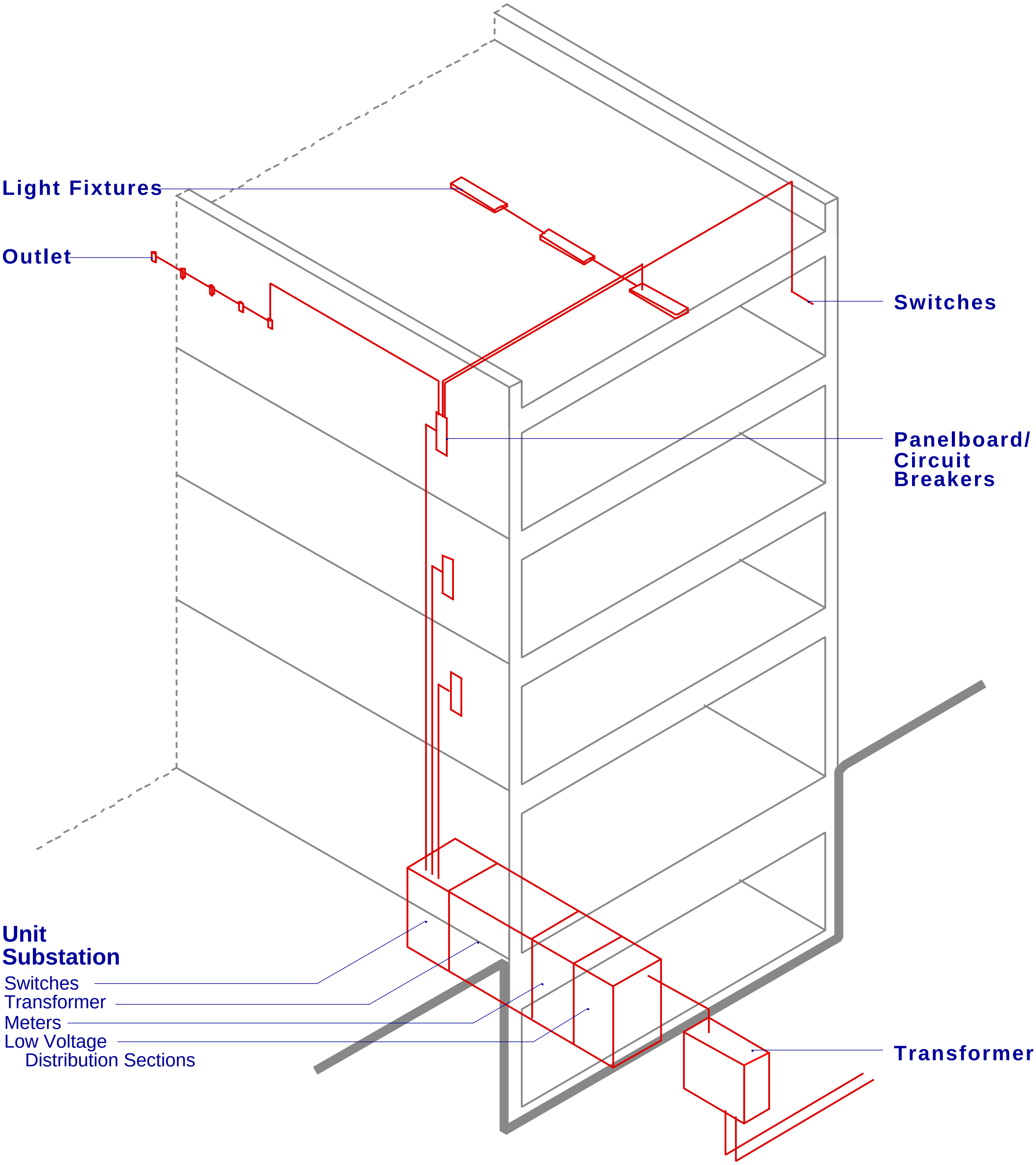


(click here for Required Engineering Documents)

MIT Department of FACILITIES
BUILDING SYSTEMS
DESIGN HANDBOOK

16 ELECTRICAL - Low Voltage



Mission Statement

The choice of equipment and the design of the installation should be developed assuming that an operating life of 40 years is not unusual.

The design will incorporate access to equipment that will allow for easy maintenance, repair and replacement, and day-to-day operation.

Interchangeability and expandability of devices and equipment is required.

As an institute of technology, MIT is always open to new ideas with consideration given to cost, maintenance and safety.

MIT promotes electrical designs and installations that minimize energy usage, maximize quality of illumination, and are not constructed with environmentally damaging materials. Recyclability of materials is an important factor to consider.

Top Ten List of Common Electrical Design Issues

(not prioritized)

1. Equipment, devices, and fixtures shall be accessible.
2. Systems (including panelboards, terminal capacity, raceway, physical space) shall be expandable.
3. Adequate receptacle coverage shall be provided. Receptacle plan shall be reviewed with end-user.
4. In labs, conduits shall be used between panelboards and surface mounted raceways to allow for expansion and flexibility.
5. Provide grounding means in labs for instrumentation equipment.
6. Equipment nomenclature shall be standardized.
7. Equipment, devices and circuits shall be labelled.
8. Steel fittings shall be used on raceways (don't use die-cast).
9. All wiring shall be stranded wire.
10. Corridor lighting shall be provided with both normal-fed fixtures and emergency-fed fixtures.
11. Shared neutrals shall not be used.
12. Review interface with the MIT electrical distribution system with the MIT Utilities Group.
13. MIT electrical permit shall be obtained from the Facilities Department. This is in addition to state and municipal permits.

Special MIT Design Criteria

Manholes (click on topic to view diagram)

1) The size of a manhole shall be 8 ft x 10 ft x 8 ft deep. Pre-cast type manholes are acceptable.
2) The exteriors of manholes are not required to be waterproofed.
3) A sump pit, which is 1 ft x 1 ft x 6 inches deep, shall be located in one of the corners.
4) Pulling irons shall be provided above and below all windows.
5) All cable racks shall be fiberglass with stainless steel hardware.
6) Ladders in manholes shall not be provided.
7) Covers shall have an AASHTO rating of H-20. They are to be 30 inches in diameter and have a one-inch hole in the center. Depending on the use of the manhole the following shall be cast into the cover:
   a) "MIT ELECTRIC"
   b) "MIT TELECOM"
8) No ground rods or ground mats shall be provided at the manholes.

Concrete Encased Ductbanks

1) Ductbanks shall be concrete encased. No reinforcing bars are required except in City of Cambridge-provided streets.
2) Conduits used in ductbanks shall be 5-inch schedule 40 PVC conduits. Minimums of two (2) spare conduits shall be provided in each ductbank.
3) When the ductbanks are poured, form work shall be provided. In addition, tamping and vibrating of the concrete shall be done to ensure that there are no voids in the concrete under or around the conduits in the ductbanks. (This is to ensure that completed ductbanks can later be excavated under and next to for the addition of other utilities in the area of the ductbanks.)
4) Electrical ductbanks shall have red marker tapes inscribed with the words, "High Voltage", installed 12 inches above the ductbanks.
5) A pull string shall be provided in all spare conduits.
6) Where conduits from ductbanks enter building foundations, the PVC conduits shall penetrate the wall and either transition to steel conduits or be terminated at pullboxes. The area around the conduits shall be sealed with grout. Conduit wall seals are not required.

Medium Voltage Cables

1) Cables shall be 15,000 volt, 350 KCM, EPR insulated (133% insulated).
2) There shall be two radial feeders serving each building.
3) All cables in manholes and pullboxes are to be identified using non-corrosive, permanent tags. The cable shall be marked with the location it is coming from and the location it is going to.
4) In a manhole cables shall be looped once around the interior after entering and once before leaving.

Load Break Loop Switches - G&W SF6 Switches

1) Construction of the switch shall be as follows:
   a) Manufactured by G&W Electric Company: no substitution
   b) Each switch shall have the following features:
      i) RAM 44-376M-40PI 4way SF6 gas switch
      ii) rated for 15,000 volts
      iii) have 4 open stud bushings ICSBO376SF
      iv) 60 inch paneled bolted frame
      v) have incoming loop cable: 3-1/C 350 kcmil Cu EPR with shield and insulated 3/0 AWG Cu ground cable

vi) Feeder cable to substation: 3-1/C 4/0 AWG Cu EPR with shield and insulated #3 AWG Cu ground cable

2) There shall be one switch provided for each single-ended substation.
   a) Configure switch cable connection as follows:
      i) Position 1: incoming loop cable
      ii) Position 2: feeder cable to substation air switch
      iii) Position 3: spare
      iv) Position 4: outgoing loop cable
   b) There shall be one spare position provided for MIT's future use when a new switch is provided.
3) There shall be two switches provided for each double-ended substation
   a) Configure switch cable connection on first switch as follows:
      i) Position 1: incoming loop cable
      ii) Position 2: feeder cable to substation first air switch
      iii) Position 3: spare
      iv) Position 4: Outgoing cable to connect to second switch
   b) Configure switch cable connection on second switch as follows:
      i) Position 1: incoming cable from first switch
      ii) Position 2: feeder cable to substation second air switch
      iii) Position 3: spare
      iv) Position 4: outgoing loop cable
   c) There shall be one spare position provided for MIT's future use when a new switch is provided.
4) In buildings with both a double-ended subsstation and a single-ended substation provide only two 4-position switches.
5) All switches are loop connected to the MIT distribution system either at 2400v or 13800v.
6) Switches shall be located in the same room as the substations.

Double-Ended and Single-Ended Substations

1) Construction of the substations shall be as follows:
   a) In general, each unit substation shall be fully rated, with an incoming load break, fused primary air switch: VPE dry-type transformer and low voltage drawout switchgear. (Cast-coil transformers may be required in some instances.)
   b) Airswitches shall be quick-make, quick-brake stored energy operation type and be operated by a spring. Switches shall have the following features or include provision for:
      i) rated for either 5 kv or 15 kv (as required)
      ii) fused
      iii) padlocking the door
      iv) door interlock
      v) an inspection window
      vi) a full height hinged main door with a foot operated door stop
      vii) hinged grounded metal safety barrier
      viii) insulated with non-hygroscope insulation
      ix) switch interlock
      x) permanent switch position indicator
      xi) padlocking the switch open or closed
      xii) key-interlock with the main breaker
      xiii) rating nameplate
      xiv) convenient operating handle
      xv) distribution of lightning arrestors
   c) Transformer shall have the following features or include provision for:
      i) delta connected on the primary and rated either 13800v or 2400v
      ii) wye connected on the secondary rated either 480/277v or 208/120 as required by the application

- iii) 220 Class H insulation with a 150 degree C rise
- iv) VPE vacuum pressure impregnation and encapsulation (or cast coil)
- v) copper windings and bussing
- vi) copper ground bus
- vii) fan cooled and the package to include digital winding temperature
- viii) fully ventilated louvers
- ix) flexible bolted link primary taps
- x) rating nameplate

d) Drawout switchgear shall have:
- i) fully rated and fully drawout metal enclosed air circuit breakers with two step stored energy closing mechanisms and rack out mechanism
- ii) overhead breaker removal crane
- iii) hinged doors
- iv) RMS digital trip units and discrete metering package with both Mod Bus and kyz pulse initiation compatibility and KYZ pulse initiation

e) The main breaker(s) and tie breaker shall be drawout type and the same frame size.
f) Feeder breakers shall be drawout type with one exception: if the application is approved by the Facilities Department, small loads can be powered by molded case feeder breakers.
g) Ground fault sensing is only allowed on the main breakers and tie breakers and shall not be installed on the feeder breakers.
h) The main breakers and the tie breaker on the double-ended substation shall not be Kirk-Keyed together.
i) Minimize the quantity of feeder breaker sizes to allow for interchageability.
j) 15% spare spaces shall be provided for future breakers.

2) Each feeder circuit shall supply power to only one primary distribution panel.
3) Except for sprinkler, there shall be no foreign systems that are not associated with the substations located in the rooms. For example, ventilation ductwork passing through the substation room that does not serve the room will not be allowed.
4) A housekeeping pad shall be provided under the substation and shall be a minimum of 4-inches high.
5) The substation room shall be air-conditioned to 86 degrees F maximum.
6) Lighting fixtures shall be powered from the emergency system in the building. The fixtures are to be located in front of the substation. Additionally, a wall mounted battery-pack emergency unit shall be located in front of the substation with the heads pointed at the front. Lighting shall be switched at each entrance.
7) There shall be both emergency powered receptacles and normal powered receptacles in the room. Emergency powered receptacles shall be colored red.
8) A telephone outlet shall be provided in the room.
9) Room shall have at least one double door. Doors shall be self-closing with panic hardware (notify architect of this requirement).
10) The use of bus duct is acceptable for distribution of power in the building. Where the bus duct passes through building floors, curbs shall be provided around the opening and the opening shall be fire stopped.

Buildings with Electrical Services provided by the Public Utility

1) Service from the electrical public utility shall be provided with transformers furnished by the utility. The service from the transformer is to be brought to distribution switchgear meeting the requirements of the switchgear section for double-ended and single-ended substations
2) Power factor correction and transient voltage surge protection on the service shall be provided.
3) The design and layout of the electrical room shall meet the requirements as listed under double-ended and single-ended substations section.

Emergency and Standby Systems

1) Engine-generator sets shall have the following construction:
   a) All engine-generators shall be diesel powered.
      i) Sets 200 kW and below shall be manufactured by: Kohler with a John Deere engine.
      ii) Sets above 200 kW shall be manufactured by Caterpillar
   b) The following shall be powered from the emergency generator:
      i) elevators
      ii) life safety system including emergency lighting, exit signage and fire alarm system
      iii) fire pumps
      iv) smoke exhaust fans
   c) Generator sets shall meet the requirements of Massachusetts Electrical Code, NFPA 110 and NFPA 99 (where applicable).
   d) Generator sets shall be rated continuous standby.
   e) On application of any load up to the rated load, the instantaneous voltage dip shall not exceed 20% and recover to + or –2% of rated voltage within one second.
   f) The generator shall be capable of sustaining at least 250% of rated current for at least 10 seconds under 3 phase symmetrical short circuit.
   g) The voltage regulator shall be isolated from the load to prevent tracking SCR loads.
   h) The engine shall be furnished with the following accessories:
      i) full flow, bypass spin on oil filters
      ii) oil drain valve and extension
      iii) dry type replaceable air cleaner element and restriction indicator
      iv) spin on fuel filters and strainers and a manual fuel primer pump
      v) racor fuel strainer/water separator(s) installed in the fuel supply line before engine fuel pump
      vi) cooling system filled with manufacturer recommended percentage of antifreeze and distilled water and coolant additive
      vii) tank type, circulating jacket water heater(s) to maintain engine at a constant 90°F to 120°F with oil pressure disconnect switches, ball valves on inlets and outlets and steel braided reinforced hoses with threaded connectors.
      viii) manifold, turbo and flex insulation blankets
      ix) 8D style lead-acid, non-maintenance free batteries with automotive posts sufficient to provide two complete sets of three crank/rest cycles of 15 seconds, 75 seconds total, each at 40°F with at least two year life cycle
      x) battery conductor total resistance not exceeding .002 ohms including negative and positive leads
      xi) a free standing battery rack
      xii) isochronous electronic speed control
      xiii) 78 ampere minimum battery charging alternator with solid-state voltage regulation
      xiv) one (1) spare set of hoses, filters, belts, fuses, thermostats and gaskets
      xv) two (2) complete Overhaul Literature Kits
      xvi) Vibration isolators for field installation
   i) A float battery charger shall be provided capable of returning the battery(s) if fully discharged to 100 % of their ampere-hour rating within 24 hours. The charger should have the following features: crank disconnect relay, manual or automatic equalize timer, adjustable charger settings, AC line compensation, automatic overload protection, fused DC output, fuse or breaker protected AC input, automatic DC regulation, and surge suppressor. It shall have a DC ammeter, DC voltmeter, low voltage alarm, high voltage alarm, power failure alarm, summary failure alarm, voltage and High DC voltage. Battery charger wiring shall be permanently connected. Connections shall not

be made at the battery terminals.

j) Engine exhaust silencer shall be critical attenuation grade, aluminized steel double wall construction equal to EM Products (JCS05-1260 with #150 ASA carbon steel flange inlet and outlet connections). Low point drain with MPT threaded end and standard high temperature (1200°F) finish shall be factory furnished. Silencer shall also be furnished with 300 series 4" diameter stainless steel braided flexible pipe connector having temperature and pressure rating to suit for connecting exhaust pipe to engine, 12 inch minimum length with #150 ASA carbon steel flange end connections.

k) A double wall (secondary containment) steel fuel tank (sub-base if possible) shall be factory furnished integral to each diesel generator. Capacity of the fuel tanks shall be not less than 12 hours but not more than 36 hours with the set operating at full load.
   i) The fuel tank shall be equipped with a removable plate with gasket for inspection and periodic maintenance with a minimum of the following fittings: engine fuel supply, engine fuel return, vent, emergency vent, fuel inlet and fuel drain. A fuel level gauge and low fuel level alarm shall be factory furnished. Piping shall be entirely black iron. Pipe sealant shall be recommended for fuel oil systems and not Teflon based. Indicating type valves shall be installed on both the supply and return lines prior to the flexible lines to the engine. A battery powered normally closed electric fuel solenoid valve and a check valve shall be factory provided on the engine supply line. Manual bypasses shall be installed for all fuel solenoid valves.
   ii) Provide fuel filter. Fuel filter shall be removable, full flow bypass spin-on, cartridge type with head piece having provisions for piping connections. The filtering media shall surround a perforated steel center tube backed by a coiled steel support spring to seal the gasketed end face of the throwaway filter element against the head piece.

l) Submittal shall include prototype test certification and specification sheets showing all standard and optional accessories to be supplied, schematic wiring diagrams, dimension drawings, and interconnection diagrams identifying, by terminal number, each required interconnection between the generator set, the transfer switch, and the remote annunciation panel. Also provided are the following drawings and instructions:
   i) bill of material and catalog cuts on each separate piece of equipment.
   ii) engine generator setting plan.
   iii) wiring schematics for engine control.
   iv) generator control panel arrangement and wiring schematics.
   v) lubricating oil specifications.
   vi) gauge board arrangement.
   vii) remote alarm annunciator arrangement and wiring schematics

m) The manufacturer shall warrant the emergency generator system for 2 years or 2,000 hours, whichever occurs first, from the date of the site start-up. The local manufacturers' representative shall provide the first complete annual service per the written maintenance recommendations for the unit at no additional charge in the twelfth month following the date of the startup. Facilities maintenance staff shall be present during the service.

n) Factory Tests:
   i) Provide standard factory tests in accordance with NEMA standards and NFPA standard 110. Check and set all instruments and safety devices. Provide following tests:
      (1) Generator set test under rated load and power factor for performance and proper functioning of control and interacting circuits. Testing at unity power factor only (resistance banks only) is not acceptable, since KW output is affected by the higher generator efficiency at unity power factor, and the KVAR for motor starting and regulation is not correlatable between unity and rated power factor.
      (2) Fuel Consumption: The Owner shall be notified in advance of these tests and shall have the option of witnessing these tests. Certified copies of these test results shall be forwarded to the Owner for review.

o) Site Tests:
   i) An installation check, start-up and building load test shall be performed by the manufacturer's

local representative in precise accordance with the acceptance testing procedure outlined in NFPA 110 para. 5-13. Facilties maintenance staff shall be notified of the time and date of the site test and be present. The tests shall include:

(1) Fuel, lubricating oil and antifreeze shall be checked for conformity to the manufacturer's recommendations, under the environmental conditions present and expected.
(2) Field leveling of generator skid shall be done prior to acceptance testing.
(3) Accessories that normally function while the set is standing by shall be tested prior to cranking the engine, including block heaters, battery charger, generator strip heaters, remote annunciation, etc.
(4) Check start-up under test mode for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and phase rotation.
(5) Test automatic start-up by means of simulated power outage for remote-automatic starting, transfer of the load and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper system coordination. Engine coolant temperature, air temperature, oil pressure and battery charge level along with generator kilowatts, voltage, amperes and frequency shall be monitored at 20 minute intervals during the four hour test. An external load bank shall be connected to the system if sufficient building load is unavailable to load the generator to the nameplate kW rating.
(6) Test all alarm shutdown circuits by simulating fault or failure conditions.

2) Automatic transfer switches shall be provided with isolation/bypass switches and shall be manufactured by Russelectric.
3) In engine/generator rooms, battery-pack wall emergency lighting units shall be provided with lighting fixtures directed at the automatic transfer switch and at the generator control panel.
4) Dampers and louvers shall fail open. Gravity type louvers shall not be used. The manufacturers recommended maximum static air inlet and outlet pressures shall not be exceeded. Ventilation shall be sufficient to maintain an engine room temperature of not more than 110'F on a 95'F ambient day when measured at any point at least 18" from the engine when operating at a sustained 100% load.
5) The room floor shall be coated with an industrial floor sealant and the walls sealed and painted.
6) There shall be 30 foot-candles of lighting to all sides of the generator when measured at the floor level.
7) Heating shall be provided to maintain the generator room at a minimum of 40° F. Provide low-temperature alarm set to alarm at below 40° F.
8) An electrical distribution panel containing all of the circuit breakers for all electrical equipment in the generator room (include battery charger, block heaters and lighting) shall be located in or adjacent to the generator room.
9) A freestanding or wall mounted cabinet shall be provided in the room containing spare parts, service equipment and operation manuals.
10) A minimum of two 120VAC electrical outlets connected to the emergency power system shall be installed within the generator room.

Distribution Panelboards

1) Construction of the panelboard shall be as follows:
   a) Provide door in door.
   b) Breakers shall be rack mounted and allow installation and removal of the breaker without de-energizing the panel.
   c) Main breaker shall be provided without ground fault
   d) All panels shall be three phase 4-wire, with copper bus.
2) Distribution panelboards shall be located in dedicated rooms and closets.
3) Feeder circuits to panels shall supply power to only one panel.

Power Panelboards and Lighting Panelboards

1) Construction of the panelboard shall be as follows:
   a) Provide door in door.
   b) Buses shall be copper.
   c) Surface mounted panels shall be provided without knockouts
   d) Every panel is to have a main breaker.
   e) A separate ground bus shall be provided.
   f) A neutral terminal strip shall be provided on each side of the panel
   g) Power panels shall have 200% neutrals.
   h) Double tub panel construction is acceptable.
   i) Panels shall be 42 pole or 84 pole capacity.
   j) As a minimum 20% spare breakers are to be provided.
   k) In general, breakers shall not be less than 20 amperes.
   l) Breakers shall be bolt-on type.
   m) Minibreakers are not allowed.
   m) Single pole breakers with handle ties or bails shall not be used in lieu of multipole breakers.
2) Panelboards are to be located in dedicated rooms and closets. Provide additional space on walls for at least one future panel.
3) Recessed panels are to have two spare one-inch conduits run from the panel to the ceiling for future use by MIT.
4) In new installations there shall be separate power panels and lighting panels.
5) There shall be a maximum of four (4) receptacles per single-phase power circuit.
6) Receptacles located in hallways and corridors shall be on their own branch circuit and shall not be powered from room branch circuits.
7) Rooftop receptacles shall be on their own branch circuits and not be powered from room branch circuits. Each rooftop receptacle shall be a GFI receptacle.
8) Neutrals shall not be shared, each single phase circuit is to have its own neutral.
9) The feeder cable to a 200% neutral panel shall have a 200% neutral.

Transformers – 600 Volts and below

1) General use transformers shall be provided meeting the requirements of NEMA TP-1 and rated energy efficient and transformers used with harmonic loads (computers) shall be provided with K-9 ratings.
2) Windings on transformers shall be copper.
3) No oil-filled transformers

Variable Frequency Drives

1) Drives shall have the following features:
   a) be a 12 pulse design minimum. VFDs over 25 hp will be an 18 pulse design.
   b) have a maintenance bypass.
   c) be designed so that there is no limitation on distance between the drive and the motor. Additionally, the motor to be used with the drive shall be a standard general-purpose type motor, not a special drive motor .
   d) The drive enclosure is to be NEMA 12.
   e) All drives shall have a lockable disconnect.

Raceways

1) EMT shall be provided with steel fittings. Die-cast fittings are not acceptable.
2) No conduit is to be embedded in basement floor slabs. Conduit is to be surface mounted.
3) All surface raceway systems shall be manufactured by Wiremold, Carlon or Hubbell. The use of

Wiremold ISO Duct Surface Raceway is prohibited. In general, Wiremold 3000, 4000 and 6000 is preferred (Hubbell and Carlon equivalent are acceptable). Non-metallic surface raceway may be used in special applications.

4) In laboratories, conduits shall be used between the panelboards and the surface mounted raceways.
5) Underground branch circuits are to be schedule 80 PVC. Direct burial of conductors is not allowed.

Receptacles and Switches

1) For requirements for branch circuits, see Power Panelboards and Lighting Panelboards.
2) For requirements for lighting fixture switching, see Lighting.
3) Devices are to be specification grade.
4) Devices shall be rated 20 amperes.
5) Device plates are to be stainless steel or nylon.
6) All switches shall be rated for 277 volt use.
7) Receptacle plans shall be reviewed with the end user to insure proper coverage for the areas being constructed.

600 Volt Cable

1) All cables shall have copper conductors.
2) All conductors are to be stranded. Solid conductors shall not be used.
3) THHN/THWN conductors shall be provided. Insulation to be 90˚ C rated with connectors sized for 75˚C ampacity use (90˚C ampacity rating of a conductor is not to be used).
4) XHHW and RHW cable shall be used for outdoor underground lighting and power installations.
5) Minimum conductor size to be # 12 AWG

Lighting

1) Switching of Lighting Fixtures
   a) Typically, motion sensors are not to be provided. The addition of these devices to encourage energy savings shall be discussed with the end user.
   b) Typically, offices and conference rooms shall be manually switched. The addition of these devices to encourage energy savings shall be discussed with the end user.
   c) Typically, classrooms shall be provided with dimmers and/or selective manual switching.
   d) Laboratories shall be manually switched.
   e) Public areas ahll be manually switched.
   f) Athletic facilities shall have the switching located in secure areas.
   g) Mechanical rooms and electrical rooms shall be manually switched at each entrance.
   h) Building exterior lighting, exterior entrance lighting and landscape lighting are to be photocell controlled. Time clocks shall not be used.

2) Lighting Fixtures
   a) Corridor lighting shall be a mixture of normal and emergency lighting fixtures to insure that the loss of one branch circuit will not cause the corridor to lose all illumination.
   b) Track lighting fixtures shall not be used except with special applications and with the approval of the stakeholder group.
   c) Lighting fixtures located in high areas shall be positioned in spaces that will allow lamp and ballast replacement with normal maintenance equipment.
   d) Flourescent lamps located over food service areas shall be provided with plastic coatings that will contain the lamp glass if the tube is shattered.
   e) Fixtures in mechanical spaces and rooms shall be provided with cages.
   f) Exterior bollard lighting fixtures shall not be used.

g) Elevator fixtures shall be located in spaces that will allow for the lamps and ballasts for those fixtures to be accessible from inside the elevator cab.
h) Mechanical rooms and electrical rooms shall have lighting fixtures located between equipment. Fixtures shall provide sufficient illumination that work on this equipment can be performed without supplemental lighting.
i) Consideration shall be give to permanent illumination for rooftop equipment.
j) Use solar power when possible and discuss with the end user.
k) Use outdoor lighting fixtures with cut-off angles that prevent light from shining upward or too far beyond the intended area of illumination. Create a LINK to Green Resources.

3) Fixture Lamps
a) Incandescent lighting shall not be used except for special applications and with the approval of the stakeholder group.
b) Fixtures requiring ballasts shall be provided with high power factor electronic ballasts.
c) Four foot fluorescent tubes shall be F32T8, 3500˚K.
d) Metal halide lamps shall be used for all exterior use.
e) Select diffusers that reduce glare and sufficiently illuminate ceilings and walls to create a visual field similar to prevailing daylight conditions.
f) Provide lamps with high color rendering index, such as tri-phosphor fluorescent lamps.

Equipment Nomenclature

MIT's standard equipment nomenclature shall be used.

Labeling of Equipment, Devices and Circuits

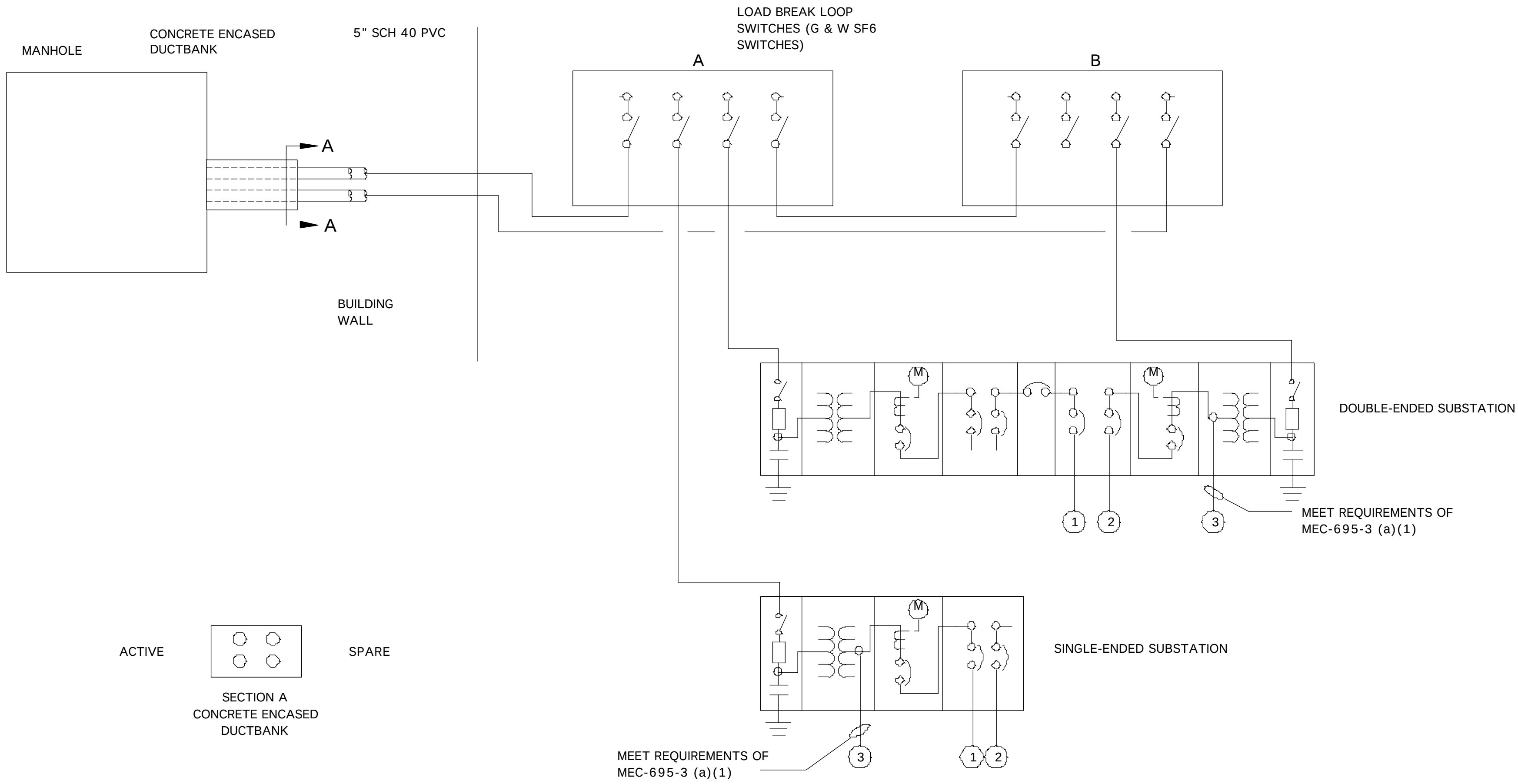
All equipment, devices and circuits shall be labeled.

Construction

Include the following requirements on electrical contract documents:

"Prior to the start of any electrical work the electrical contractor is to obtain a MIT Electrical Permit from the MIT Facilities Department and a City Electrical Permit."

(At the time of permitting, details of notification for MIT Facilities observation will be issued.)



TYPICAL BUILDING SERVICE ENTRANCE

MASSACHUSETTS INSTITUTE of TECHNOLOGY

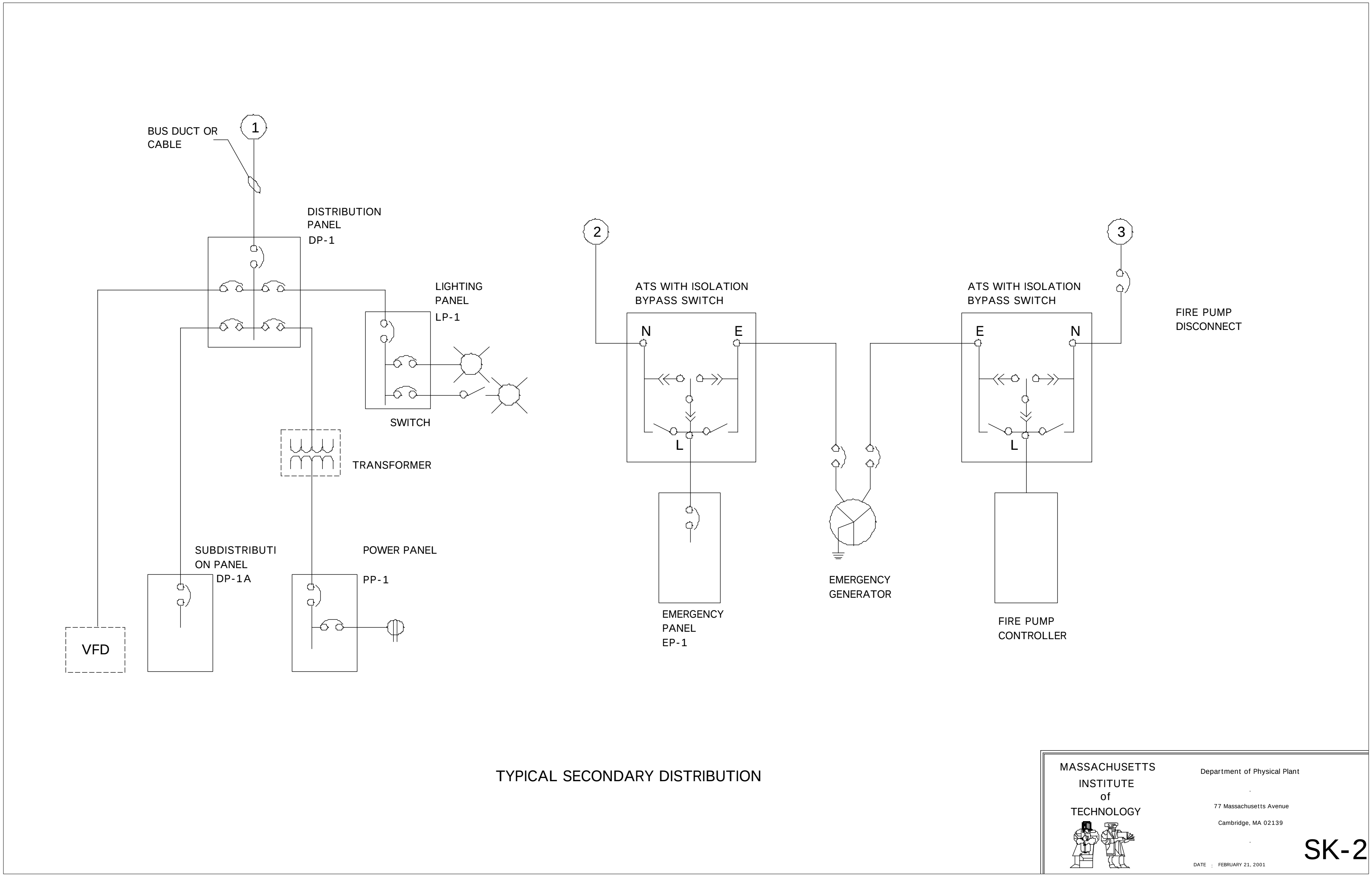
Department of Physical Plant

77 Massachusetts Avenue

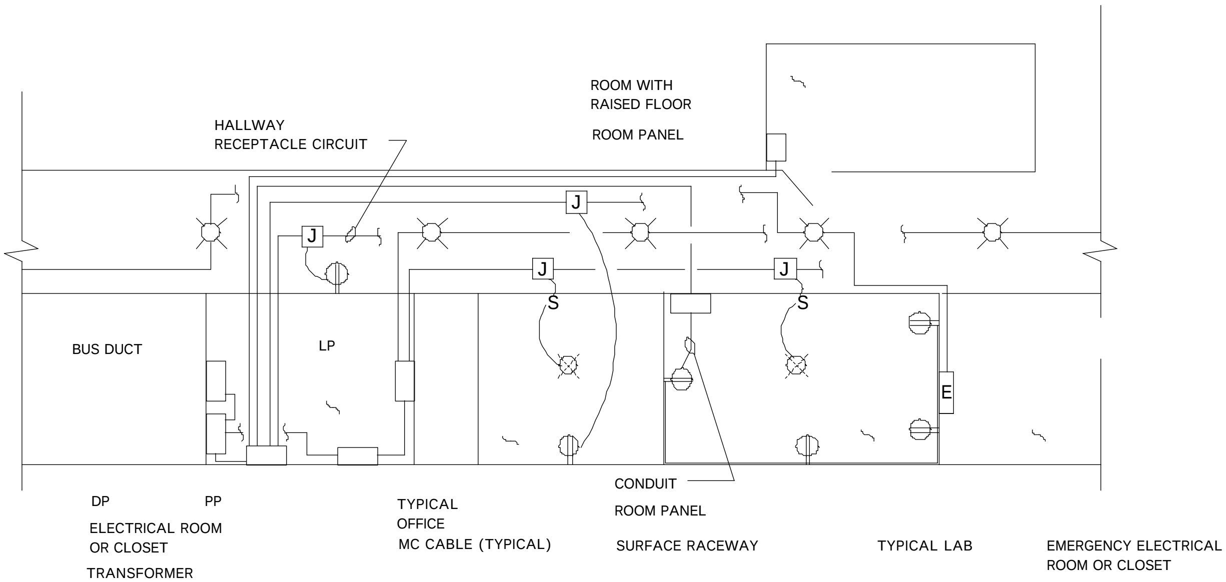
Cambridge, MA 02139

DATE : FEBRUARY 21, 2001

SK-1



TYPICAL SECONDARY DISTRIBUTION



TYPICAL ELECTRICAL PLAN

MASSACHUSETTS INSTITUTE of TECHNOLOGY

Department of Physical Plant

77 Massachusetts Avenue

Cambridge, MA 02139

DATE : FEBRUARY 21, 2001

SK-3

List of Products

	MIT Requirements
Raceways	
Conduit	No preference
Surface mounted	Carlon, Hubbell and Wiremold
Cable	
Medium voltage cable	Okonite and Kerite
Low voltage cable	No preference
Transformers	ABB, Cutler-Hammer, GE, Siemens, and Square-D
Load break switches	G & W Electric Co.
Low voltage unit substation	ABB, Cutler-Hammer, GE, Siemens, and Square-D
Motor control centers	Allen-Bradley, Cutler-Hammer, GE, Siemens, and Square-D
Motor starters	Square-D
Distribution panel	Square D I-line, Cutler-Hammer Pow-R-Line 5P
Lighting panels	Cutler-Hammer, GE, Siemens, and Square-D
Engine generators	Kohler Power Systems and Caterpillar
Battery systems	Exide and C-D
Automatic transfer switches	Russelectric
Manholes and handholes	No preference
Metering	ABB, Cutler-Hammer, GE, Siemens, and Square-D
Wiring devices	Hubbell, Arrow-Hart, Leviton
Lamps	Phillips and Osram
Ballast (F32T8)	Osram
Dimmers	Lutron and Crestron
Fuse	Bussman and Shawmut
Disconnect switch	ABB, Cutler-Hammer, GE, Siemens, and Square-D
Busway	ABB, Cutler-Hammer, GE, Siemens, and Square-D
Power factor correction	No preference
Grounding	Cadwell and Burndy
Transient Voltage Surge Protection	ABB, Cutler-Hammer, GE, Siemens, and Square-D
Lighting Protection	No preference
Lighting fixtures	No preference
Motors	No preference
Variable Frequency Drives	Robicon, ABB, Cutler-Hammer, Allen-Bradley
Uninterruptible Power Supplies (UPS)	Liebert and Mitsubishi
Heat Tracing systems	Raychem and Nelson
Fire alarm systems	Simplex and Grinnell
Cathodic Protection systems	No preference
Leak Detection systems	No preference
Fire Stops	No preference

Green Design Opportunities

Light Bulb Storage/Recycling Room

Oil collection facility for compressors, generators, G&W, Elevators

Upsized conductors to reduce voltage drop.

Variable frequency drives.

No oil-filled transformers.

No incandescent lamps.

Additional Resources

1) Electrical Motors & Drives

   Department of Energy, *Energy-Efficient Electric Motor Handbook*, Revision 3, Washington, DC, 1993.

   Hoslida, Robert K., "Electric Motor Do's and Don'ts," *Energy Engineering*, Vol 19, No 1, pp 6 - 24.

   Nadel, Steven, et al., *Energy Efficient Motor Systems: A Handbook on Technology Programs, and Policy Opportunities*, American Council for an Energy-Efficient Economy (ACEEE), Washington, DC, 1991.

2) Appliances

   American Council for an Energy Efficient Economy (ACEEE), *The Most Energy-Efficient Appliances-1996 Edition*, Washington, DC.

3) Energy Management and Controls

   Electric Power Research Institute, "Energy Management Systems," (Technical Brief TB.EMU.121.4.87), Palo Alto, CA (510) 934-4212

4) Electrical Systems and Equipment
   a) Locate motors that operate needlessly, for example there may be multiple HVAC circulation pumps operating when demand falls, ceiling fans on in unoccupied spaces, etc.
   b) Avoid electromagnetic pollution/exposure - install electromagnetic field shielding.
   c) Limit electrical demand during peak hours by turning off non-essential equipment.
   d) Use energy-efficient equipment and appliances with timing devices. Computers, monitors, copiers, fax machines should be Energy Star-compliant.

Repair and Maintenance Issues

(This section to be added)

Environmental Health and Safety Issues

(This section to be added)

Institute Spaces and Art, Architecture and Preservation

(This section to be added)

Laboratory Services

(This Section to be ADded)

Design Review Checklist

SCHEMATIC DESIGN

The following shall be provided for the schematic design submittal.

___ 1) Preliminary motor and load list (Profile load and give voltages.)
  ___ a) Lighting loads
  ___ b) Power loads
  ___ c) HVAC loads
  ___ d) Elevators loads
  ___ e) Emergency loads (including fire pump)
  ___ f) Critical loads
___ 2) Engine/generator size
  ___ a) Life safety
  ___ b) Optional standby
___ 3) Preliminary watt/SF load including support documentation for selection
___ 4) Preliminary electrical distribution riser diagram
  ___ a) Show approximate configuration.
  ___ b) Show preliminary distribution equipment sizes for substations and panels.
  ___ c) Provide for substations: voltage, bus ratings and transformer size(s).
___ 5) Initial short circuit currents and short circuit bracing for equipment (Contact MIT Utilities for requirements.)
___ 6) Programming
  ___ a) List of electrical spaces and rooms
  ___ b) Service entrance requirements
  ___ c) Service provider (MIT or NStar)
  ___ d) Existing conditions plan, properly documented
___ 7) Provide overall oneline diagram.

Signature of Responsible Electrical Engineer ________________________________
Dated ________________________

DESIGN DEVELOPMENT

The following shall be provided for 100% design development submittal.

___ 1) Final plans including
  ___ a) Substation and panel final breaker frame sizes and trip sizes
  ___ b) Final conduit and wire schedules
  ___ c) Final panelboard schedules
  ___ d) Final fixture schedules
  ___ e) Final engine/generator size(s)
  ___ f) Final risers and one line diagrams for power distribution system,
  ___ g) Final risers for fire alarm system and communication system
___ 2) Final specifications
___ 3) Final motor and load list
___ 4) Completed short circuit analysis
___ 5) Lighting calculations
___ 6) Voltage drop calculations

Signature of Responsible Electrical Engineer ________________________________
Dated ________________________

BID DOCUMENTS

The following shall be provided for bid document submittal.

___ 1) Bid package including specifications and stamped drawings
___ 2) List of deviations or changes from the 100% design development submittal
___ 3) Plans, specifitcation and calculations have been reviewed.

Signature of Responsible Electrical Engineer ___________________________________

Dated ____________________________

APPENDIX A
PROGRAM REQUIREMENTS FOR COMMON SPACES AND FUNCTIONS
(New Section)

1. **Rubbish/Trash Rooms Inside Buildings:** For interior rubbish rooms, provide a minimum space of 200 s.f. Comply with guideline Section 11170 and 526 CMR 34.

   A. Conditions:

      1) Must be sprinklered
      2) Fire walls on all sides
      3) Pair of fire resistant doors 5’-0” x 7’-0”.
      4) Floor drain
      5) Hot and cold water with spigot to accept hose and drain.
      6) Located adjacent ot loading plafform, or if in basement, next to freight elevator.

2. **Rubbish/Trash Handling Outside Buildings:** Comply with Guideline Section 11170 and 527 CMR 34.

3. **Grounds Equipment Storage Space:** Provide a separate unshared space for grounds equipment storage in each noew building. Area of grounds equipment storage space will be related to size of new building. Obtain approval of square foot area from MIT Grounds Department Manager and MIT Project Manager.

4. **Custodian Service (Janitor’s) Closets:** The minimum size for a service closet is 30 s.f.

   A. Conditions:

      1) If center or single corridor – one per floor midway to each end.
         If perimeter corridors, two per floor on each side located midway to each end.
      2) Hot and cold water with spigot to accept hose.
      3) Light.
      4) Floor type receptor with 6” to 8” curbs.
      5) Not to be shared space.

5. **Building Services Equipment and Supply Room:** Provide a room with a minimum of 300 NSF. The square footage and amount of equipment and supplies will depend on the building to be served.

   A. Equipment and Supplies:

      1) Storage of paper towels and toilet tissue.
      2) One rack, 48” x 18” x 72” to store miscellaneous cleaning supplies.
      3) Drum Storage: 4 drums of 55 gallon size.
      4) Space for water pickup vacuum (55 gallon cap)
      5) Space for floor polishing machines.
      6) Space for vacuum cleaners.
      7) Space for battery powered automatic scrubber.
      8) Space for Custodial carts.

   B. Conditions:

      1) Normal building heat.
      2) Recessed light fixtures providing 75 F.C. of light.
      3) Hard surface walls.
      4) Forced ventilation with fan to remove hydrogen gas created by batteries on charge.

5) Grounded explosion-proof electrical outlets (2)
6) Pair of doors 5'-0" x 7'-0" opening in to corridor.
7) Floor type receptor with hot and cold water. Spigot to be 24" above floor. Basin curbs to be 6" to 8" high due to wash and drain equipment required.
8) Room should be approximately square and located near elevators
9) Must not be shared space (no telephone panels, electric panels, pipe chase openings, etc.)
10) Floor to be troweled cement.

6. **Building Services Locker Rooms:** Provide one for men and one for women at 250 s.f. each. The area requirements may vary depending on the size of the area to be served.

A. Equipment:

1) Two lockers per individual each 12" x 18" x 72".
2) Lunch tabel and chairs
3) Benches for use in fron t of lockers
4) Shower stall (if possible).

B. Conditions:

1) Normal building heat.
2) Recessed light fixtures providing 75 F.C. of light.
3) Not to be shared space.

7. **Mail Room:** Provide a mail room of 50 NSF minimum. The actual area may vary depending on the size of the building being served.

A. Equipment:

1) Two tables 36" x 72" each.
2) Mail cart 28" x 48".
3) Cork bulletin board 4' x 8'.
4) Small desk and chair.
5) Storage cabinets 18" x 36" x 72"
6) Mail bins mounted on tables / wall.

B. Conditions:

1) Normal building heat and air conditioning.
2) Recessed lighting fixtures providing 75 F. C. of light.
3) Two electrical outlets.
4) Located on first floor near receiving facility (if any).
5) Door at least 36" wide.
6) No to be shared space. (Note: All mailrooms fall under "restricted space" since we handle U.S. Post Office mail, special category, etc.)

END OF APPENDIX A

APPENDIXB
M.I.T. BUILDING SERVICES SPACE CLASSIFICATIONS

1. **Classifications:** M.I.T.'s Building Services Department classifies spaces into the following categories. These categories are sometimes used in the Guidelines [ispecially in Division 9 guidelines for floor finishes].

   A. PUBLIC SPACES: Areas at main entrances, main floor corridors, primary circulation areas near major lecture rooms and headquarters.

   B. M.I.T. SPACES: Corridors and through traffic spaces which do not receive as much traffic as Public Spaces.

   C. GROUP USE SPACES: Spaces which are used primarily by the occupants of the space with little or no through traffic.

   D. UTILITY SPACES: Back-of-house mechanical and electrical areas typically used only by M.I.T. maintenance staff.

2. **Requirements:** M.I.T.'s Building Services Department has established the following guidelines for the above classifications:

   A. PUBLIC SPACES: Provide hard, durable, easy-to-clean floors which can withstand tracked-in snow, water, and heavy traffic. Provide only slip-resistant surfaces. Terrazzo, stone, ceramic tile, and masonry pavers are examples of acceptable finishes. Review slip-resistance with M.I.T. Safety Office prior to floor selection.

   B. M.I.T. SPACES: Vinyl composition tile, seamless flooring, and finishes used in Public Spaces are acceptable. Use carpet only where it is truly needed. Avoid the use of carpet in ares with wheeled traffic high traffic, water, and food service.

   C. GROUP SPACES: Same as for M.I.T. spaces. The floor finish shoudl be selected to suit the intended occupancey [example: seamless flooring in labs].

   D. UTILITY SPACES: Typically sealed concrete is sufficient. See Guidelines 03345 and 09710.

END OF APPENDIX B

APPENDIX D
OFMS Space Accounting Group Numbering Systems
(New Section)

1. **Jurisdiction:** The Office of Facilities Management Systems is M.I.T.'s official source for building, wing, and room numbers.

2. **History**: The original M.I.T. complex, Buildings 1 through 10, built in 1916, were numbered by referenceing a southeast to Northwest axis running from the Charles River toward the Building 10 Dome. Those buildings to the West of that reference axis were given odd numbers, beginning with the building closest to the River; and even numbers to the East, with the same ascending numbering scheme.

3. Official Numbers: Every M.I.T. building, owned or leased for academic pruposes, has an "official" building number. Select buildings also incorporate a wing designation as wel. (Examples are bldg. 14N, 20A, etc...). room numbers incorporate the building and wing number, and the appropriate floor designation, similar to the "Hotel System", for spaces accessed from public corridors. The "Suite System", with letter suffixes, is used for internally accessed spaces. The table below notes the special room number suffixes used for public circulation, building service and mechanical areas as well as mezzanine spaces.

TABLE

Area:	Type:	Sample Suffixes:
Building Service	Janitorial Areas	123J
Circulation	Bridge / Tunnel	100CA, 100CB, etc.
	Corridor	100CA, 100CB, etc.
	Elevator	100E1, 100E2, etc.
	Lobby	100LA, 100LB, etc.
	Stairway	100SA, 100SB, etc.
Mechanical	Shaft Space (Accessible)	123Z
	Elec/Tel Closet (Electrical)	123E
	Elec/Tel Closet (Telephone)	123T
Mezzanines	All Room Types	123M

4. **Assignments:** Room numbers are assigned by considering the location of each room within its building grid. A building grid is the tool used to establish and maintain a room numbering scheme for a building. Typically, the grid represents the centerlines of the columns of the buildings structural bays. Thus there is a unique grid for each building. Each cell of the grid is assigned a range of numbers from which individual room numbers can be drawn for rooms accessed from within the structural bay represented by that cell.

5. **Procedure:** When there is a reconfiguation of space and the need arises for new room numbers, the appropriate steps to follow to gain new room numbers are as follows:

   A. Convey to the OFMS Space Accouting Group the specifics of the change generating the need for the new room numbers. Typically, this is done by supplying the OFMS with a drawing or sketch of the proposed space changes.

   B. OFMS will assign room numbers and return a marked up copy of the drawing or sketch as quickly as possible. These assigned room numbers are considered "official". Consequently, if any further changes occur that impact room numbering during design and construction, the OFMS SAG should be contacted again as soon as possible.

C. When OFMS receives a completion notice from the Construction and Space Management Group the reconfigured space will be verified for “as built” conditions by OFMS in an ad hoc audit. The change information will be entered into the M.I.T. Space Inventory in a manner that maintains information equivalence between INSITE CAD and INSITE Database systems.

D. Reconfiguration and resulting room number changes that do not pass through the CRSP / Physical Plant adminstered space change process, are identified and inventoried furing the sytematic annual field audit of all M.I.T. spaces conducted by OFMS. OFMS will notify the Construction and Space Management Group of needed conrrections to room number signage identified during the course of the audit.

END OF APPENDIX D

MIT Stakeholders Groups

Department of Facilities Directors:

Project Management Approach
Capital Projects
Space Changes
Special Projects

- Victoria Sirianni
- Paul Curley
- Deborah Poodry
- David Meyers
- Peter Cooper
- Jim Wallace

Planning / Program/ Design:

- MIT Project Planner
- MIT Project Manual

Budget / Schedule / Construction:

- MIT Project Manager
- MIT Project Manual

RETURN TO MATRIX

MIT Stakeholders Groups

Site & Landscape:

Talitha Fabricius
Norman Magnuson
John Butts
Austin Petzke
Michael Smith
Peter Cooper
John McDonald
Raul Varela
Laxmi Rao

Consultant: Julie Ferrari

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MIT Stakeholders Groups

Shell & Finish:

Hans Antonsson
Joe Gifun
Steve Miscowski
Robin Arena
Joe Vella
Austin Petzke
John Dembrowsky
John Hawes
Dave McCormick

Consultant: Imai / Keller, Architects

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MIT Stakeholders Groups

Interiors:

David Silverman
Clara Romero
John Meneghini
David Myers
Susan Skrupa
Maureen Ahearn
Ron Filosa

Consultant: Io Oakes

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MIT Stakeholders Groups

Utilities:

Roger Moore
Vaughn Crayton
Paul Stordy
Jack Allen
Laxmi Rao
Bill Wohlfarth
Vaughn Crayton
Laxmi Rao
Pat Magner

Consultants: Vanderweil Engineering
SEA Consultants

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MIT Stakeholders Groups

Plumbing:

Raul Varela
Jack Allen*HVAC:*
Lakhan Verma
Bob Cunkelman
Jack Mannion
Carl Hagge
Roger Moore
Warren Scott
Jack Allen
Steve Miscowski
Laxmi Rao

Consultants: Vanderweil Engineering

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MIT Stakeholders Groups

HVAC:

Lakhan Verma
Bob Cunkelman
Jack Mannion
Carl Hagge
Roger Moore
Warren Scott
Jack Allen
Steve Miscowski
Laxmi Rao

Consultants: Shooshanian Engineering

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MIT Stakeholders Groups

Controls:

Jack Mannion
Bob Cunkelman
Karl Hagge
Warren Scott
Bernie Richard
Steve Miscowski

Consultant: Shooshanian Engineering

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MIT Stakeholders Groups

Electrical:

Bill Wohlfarth
Paul Stordy
Steve Miscowski
Peter Cooper
Steve Gilligan
Howard Harrison
Brian Winsor

Consultants: Fay Spofford & Thorndike

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MIT Stakeholders Groups

Fire Protection

Joe Pinciaro
Howard Harrison
Bill Wohlfarth
Steve Miscowski
Peter Bochnak

Consultants: FirePRO

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MIT Stakeholders Groups

Information Systems:

Brian Shannon
Andrew Bonvi
John Dunbar

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MIT Stakeholders Groups

Campus Framework:

John Hawes
Talitha Fabricius
Jane Farver
Jane Pickering
Katherine Willmore
Gayle Gallager
David Myers
Hans Antonsson
Kelley Brown
David Silverman
Joe Gifun
Anne Glaven

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MIT Stakeholders Groups

Lab Services:

- Jack Allen
- Jack Mannion
- Raul Varela
- Vaughn Crayton
- Warren Scott
- Bernie Richard

Consultants: BR+A

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MIT Stakeholders Groups

Operations

- Steve Miscowski
- Jim Wallace
- Dave McCormick
- Bernie Richard

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MIT Stakeholders Groups

Environment Health Safety:

Lou Diberardinis
Pam Greenley
Bill V
Barry Mendes
Bob Edwards
Penny Guyer
Bill McShea
Jerry Diaz
Joe Pinciaro
Jennifer Combs
Vaughn Crayton

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MIT Stakeholders Groups

Green Design:

Hans Antonsson
Talitha Fabricius
Jim Curtis
Bob Clifford
Lou Diberardinis
David Silverman
Joe Pinciaro

Consultants: Elizabeth Cordero

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MIT Stakeholders Groups

Special Occupancy Requirements:

MIT Project Planner

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