

# ***MichiganTech***

Facilities Management

Michigan Technological University

Houghton, Michigan

Construction Standards  
For  
Architects, Engineers, Planners

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# Construction Standards For Architects, Engineers, Planners

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## **00100 General**

The architect is required to tabulate a comparison between the University's programmed areas and the designed net assignable square feet of each room. All laboratory areas shall be designed in modular units with all utilities included for each area to provide for maximum flexibility and utilization of present and future space needs. Also, the schematic drawings shall include the facility number as listed in the program.

**Drawings:** Upon completion of each phase of design, the Professional shall provide mylar transparencies and electronic files of all drawings.

**Environmental Requirements:** On any project involving existing facilities, check for existence of asbestos, PCB's and any other hazardous materials, and incorporate into the project documents for removal of the same.

**Code and Safety Requirements:** The architectural and engineering design shall be in accordance with all national, state, and local codes and ordinances.

**As-Build Drawings:** Upon completion of the project, electronic files and mylar transparencies of architectural, mechanical, and electrical as-built drawings are to be supplied to the owner not later than six weeks after notice of completion has been processed.

Drawings: All project tracings and drawings are to be produced on sheet size 24" x 36".

## **00200 Building Site Utilities**

### **00210 Site Planning**

All preliminary planning must conform to the master plan for the University. In general, all building entrances except for loading docks shall be at grade level with no steps.

### **Physical Master Plan Principles**

The Physical improvements recommended in the Supplemental Plan will not only contribute to the detailed character of campus but also help unify it. The continued recognition of physical planning principals is an essential component of the Plan. These are as follows:

1. Combine both research and instructional facilities within the academic core and within a 10-minute walk.
2. Link functionally related buildings with enclosed connections to provide protection from the severe winter climate.
3. Enhance the University's relationship with the community, relocating non-academic functions in downtown.

4. Explore opportunities to utilize available off-campus space for housing, storage and other non-academic functions.
5. Upgrade the open space character, landscape quality and spatial definition of the pedestrian core between building groupings.
6. Maintain a strong sense of orientation to the Portage Lake Valley by protecting valley views from key viewing areas.
7. Maintain a strong sense of architectural continuity while minimizing long term maintenance costs through the continued use of brick and stone.
8. Utilize topography to accommodate large buildings.
9. Establish a clear entry image and sense of arrival at the western and eastern extremities of the campus.
10. Increase utilization of parking at the Student Development Complex.

#### **00211 Building Site Development**

Areas around the building shall be designed and landscaped for adequate pedestrian and vehicular movement and controls, minimum maintenance and upkeep, compliance with ADA Handicap accessibility and retainage of natural beauty.

#### **00212 Parking Lots**

Provide adequate, lighted and paved parking around the building, well drained, with consideration for snow removal equipment, snow storage areas and parking entrance and exit controls.

Parking lots should be constructed early during construction or prior to building construction for contractor's parking and storage when so required by the University.

#### **00213 Sidewalks**

Sidewalks are to be provided for proper access to building entrances and exits and campus circulation. Sidewalks are to be 10' wide, 6" thick concrete with 6 x 6 x 6 wire mesh and conduits provided for future utility crossings. A metal marker is to be provided in the sidewalk at conduit crossings.

#### **00214 Soil Borings**

Soil boring locations will be determined by the Architect.

## **00215 Irrigation**

Outdoor grass areas should be provided with irrigation systems. Proper storm drainage should be provided.

## **00220 Utility Considerations**

### **00221 General**

All elevations for profiles and campus coordinates should be tied into the USGS marker at Library Building #17.

Excavation plans should indicate all underground utilities and the effects of new grading should be carefully coordinated with existing utilities and other appurtenances.

On one drawing, all existing and all new utilities shall be shown to make apparent any interferences and to help in coordinating the connection of new utility systems to the existing.

All new utilities are to have profile drawings to show elevations for construction and clearances from other utilities.

### **00222 Steam**

Central steam is available at 80 psi to new structures for heating, air conditioning and other needs. This system is generally extended from walk-through tunnel through a U-CON mini-tunnel to the building.

### **00223 Potable Water**

Potable water is provided by a central distribution system at a nominal 85 PSIG. Softening on a limited basis is provided in buildings requiring same.

### **00224 Sewers**

Sanitary sewers are connected to central sewer system leading to city sewage plant. Storm water is run separately into a central storm system.

### **00225 Natural Gas**

Natural gas is supplied by Semco medium pressure system available on campus.

### **00226 Electric**

Electricity is provided by the MTU 12470 primary voltage distribution system.

## **00300 Building Design Requirements**

### **00310 General**

The following construction practices and design parameters are intended to keep energy consumption in new buildings as low as possible.

The total building design should include energy conservation considerations. The existing and new building's insulation, windows, heating and ventilating system, and electrical system should provide for the most efficient energy use. Provisions should be made to include this facility in the University's central monitoring and control system. Energy conservation design documentation shall be provided to MTU's Facilities Management.

### **00320 Architectural Considerations**

#### **00321 General**

Maintain the strong sense of architectural continuity on campus while minimizing long-term maintenance costs through the use of brick and stone.

The orientation of the building, roofs, entrance and walks shall minimize snow and ice buildup and the effects of northwesterly winds.

The building should be oriented on the site in a manner that will reduce the effect of winter winds on heating and summer sun on cooling.

Economic use of materials, simplicity of construction, and ease of maintenance must be considered in all structural design.

Structural drawings shall indicate the soil pressure used for footing design and design loads used in designing floors, roofs, stairs, etc.

Provide a 4 foot frost wall foundation.

Equipment vibrations and sound transmission should be thoroughly investigated.

All openings into the buildings shall be rodent-proofed. Basement windows and other openings which might provide access will be provided with double strength screening or regular screening and hardware cloth. Collars should be provided around all pipes entering a building from tunnels, outside rooms, or from the outside; collars should also be provided around pipes between rooms within the building.

ADA requirements shall be incorporated into the building from the conceptual design stage such that they are a "natural" part of the building.

Architect should become familiar with the central control system concept and design buildings considering its potentials including fire alarm, security, card access systems, and temperature control.

## **00322 Structure**

No skylights will be allowed on buildings.

Avoid masonry overhangs which are attractive to bird nesting.

No occupied spaces directly above building overhangs.

Exterior shell of building (walls, roofs, doors, and windows) shall have optimum insulating value. Window areas should be kept to a minimum and thermopane LOOE coating glass employed in all necessary windows.

Bottom height of glazing should take into account snow accumulation at grade.

Provide vestibule entrances to eliminate excessive air infiltration.

No exterior steps at building entrances.

No below grade appendages.

### **00322.10 Criteria**

#### **00322.11 Design "U" Factors**

Architect to design building to meet the following minimum requirements:

Roof and Ceiling	U = 0.05
Opaque Wall Area	U = 0.07
Gross Wall Area	U = 0.16
Windows	U = 0.33

## **00323 Roof**

Roof system to be single membrane, adhered or mechanical fastened with positive drainage. Insulation shall be Hi-Density Extruded Polystyrene such as DOW Styrofoam or Foamular 250 insulation, min. 4" thick. Walkpads to roof mounted equipment are required for maintenance.

## **00324 Walls**

Cavity wall insulation shall be lower density extruded polystyrene such as Dow Grayboard or Foamular 150. Building must have a continuous and complete infiltration barrier and a continuous and complete thermal barrier. Structural components must be placed in a fashion to allow thermal barrier to be complete. Detail must show how thermal barrier is to be constructed.

### **00325 Floors**

Live load design shall be shown on all Architectural and Structural plans.

### **00326 Stairs**

Interior stairs shall be steel channel stringers with concrete filled steel pan treads, and steel risers welded on angles to stringers capable of supporting a live load of 100 lbs per sq. ft.

### **00327 Entrances**

Arrange door swing so prevailing winds will close them. On multiple door installation, doors shall have the same swing.

All entrances shall have vestibules with recessed clean grates and pan. The clean grate shall be the full size of the vestibule. The main entrances shall be provided with extensive snow, mud, and sand traps.

### **00328 Side Lights**

Side lights should be designed or protected in such a manner that they will not be mistaken for doorways. All side lights shall have horizontal crossbar at door latch level to provide rigidity.

### **00329 Finishes**

Architects shall provide detailed door and finish schedules.

All first floor corridors and other heavy traffic areas shall have non-skid quarry tile. All other floors should be vinyl composition tile or carpet unless otherwise specified on the individual room description.

Heavy traffic areas such as corridors, lobbies, waiting areas, stairways, etc., shall have a durable, washable wall finish.

Proper anchorage should be provided for blinds. A continuous wood member the depth of the reveal is usually the most satisfactory.

No materials requiring painting shall be selected for use on the exterior of building.

Exterior doors shall be aluminum, or galvanized. All miscellaneous exterior steel, including lintels, shall be hot dipped galvanized.

Interior doors shall be solid core wood or hollow metal.

All suspended ceilings shall be acoustic 2 x 2 tiles.

### **00330 Windows**

Windows shall be double glazed with low-E glass with thermal breaks. Window units to be low infiltration units, 0.10 CFM/LF of sash opening maximum. Vent windows shall be awning type.

### **00331 Doors**

Aluminum entrance doors shall be monumental type, 3/16" thick minimum aluminum extrusions, and shall have two pair ball bearing hinges with no offset hardware. Doors opening out of occupied space shall have one non-removable hinge pin.

### **00332 Hardware and Door Control Systems**

Door hardware to be rim mounted panic hardware devices and mortise lock sets. Key system to be Best 7 pin D keyway Master Lock System. Provide combined cores for lock sets as coordinated with Public Safety. Provide hydraulic closers with hold open feature and wall mounted door stops.

**Door Control Systems:** See 00369 Communication Systems

### **00333 Elevators**

Elevators shall be provided to handle the moving of furniture, equipment, and passengers. A separate freight elevator will be required to handle heavy equipment and materials. Passenger elevators shall be provided to properly accommodate building occupancy. Acceptable elevator suppliers shall be limited to those with established maintenance capabilities within 100 miles of Houghton, Michigan.

### **00334 Service Dock**

There shall be a service dock facility available to the main access corridor servicing the building.

### **00335 Clocks**

Clocks shall be installed in all classrooms and instructional labs. The clocks should be in accordance with those now in use on campus.

### **00336 Drinking Fountains**

In general, the drinking fountains will be of the unit refrigerated type and to be wheelchair accessible. Locations and quantity are to be established during preliminary planning.

### **00337 Public Rest Rooms**

Adequate space required for public rest rooms should be included. These facilities should be designed for convenience to the public, faculty, and students served in the various

programs conducted in the building. Provisions for the physically handicapped shall be incorporated into the design of the rest rooms.

#### **00338 Emergency Generators**

A natural gas fueled emergency generator is required to maintain safety and shall be sized to comply with governing codes, including operation of elevator, TC air compressor, sump pump, building perimeter heating systems and emergency lighting.

#### **00339 Building Directory**

Major entrances should be provided with a glass-enclosed directory. Directory shall be in accordance with those existing on campus.

#### **00340 Interior Signage**

Building interior signage must meet University and ADA requirements for size, lettering and message conveyed.

#### **00341 Bulletin Boards and Display Cases**

Glass-covered, self-lighted bulletin boards and display cases shall be located in the main corridors. The major portion of these display cases and covered bulletin boards should be recessed.

#### **00342 Communications and Computer Systems**

Conduits for computer data, voice, and closed circuit television communications shall connect labs, classrooms, and other areas. This requirement is noted in the facility descriptions.

#### **00343 Telephones**

The number and locations of telephones shall be indicated on preliminary drawings. A telephone shall be provided for public use within the building.

#### **00344 Vending Machines**

A vending machine area should be located so that it could be serviced from out of storage areas. It should be recessed in corridors so that it does not impede the flow of pedestrian traffic.

### **00345 Maintenance Personnel Access**

Provide access to each roof level by doors or permanent ladders and roof hatch.

Provide access panels in all ceiling and wall areas to access valves, controls, piping, etc. Each area with a plastered ceiling must have at least one access hatch.

Mechanical equipment spaces should be accessible to maintenance personnel without extensive travel through finished areas. Elevator access should be provided where feasible. Ship ladders are not considered access.

Mechanical equipment space should be designed so a maintenance mechanic can tour all vital pieces of equipment without stepping over or ducking under obstacles.

### **00346 Service Facilities**

Each building shall have one main custodial room for exclusive use by the custodial force. It shall also be located near the service/freight elevator if one is included in the building.

Name of facility and requirements of each are attached as Figure(s) 1-5 on the next five pages.

- Storage Room/Supplies
- Custodial Closets
- Custodial Room
- Building Attendant's Office
- Receiving Area/Loading Dock

**Service Facility**

Name of Area Storage Room - Supplies

Subheading \_\_\_\_\_

No. Required 1 No. of Occupants \_\_\_\_\_

Total Floor Area (sq. ft.) 300

Configuration (ft. x ft.) \_\_\_\_\_

Use: UG Instruction\_\_\_ Grad/Research\_\_\_\_\_ Pilot\_\_\_ Departmental X

**Brief Description of Use:**

For receiving, unpacking, and storage of custodial supplies, materials, and equipment for building maintenance.

**Other Facilities and areas that should be in close proximity:**

General area of Building Attendant's Office.

**Equipment to be located in area (existing E or new N):**

Build-in shelving (18' wide, full hgt-(N) 1 flr-type slop sink with hose bib  
1 21" buffer & scrubber - (N) 2 wet & dry vacuums - (N)  
1 19" buffer & scrubber - (N) 2 upright vacuum cleaners - (N)  
1 back-pack vacuum

**General furniture requirements (seating, work tables, etc., with approximate number of stations):**

1 work bench - 3' x 6' 3 ladders (various lengths)  
2 chairs 1 lot hand tools  
1 hand dolly  
1 delivery cart

**Special Requirements (check those needed and describe those possible):**

<b>Electrical</b> <u>110V, 220V</u>	<b>Ceiling Height</b> <u>Standard</u>
<b>Distilled Water</b> _____	<b>Wide Door</b> <u>Double-wide, no cent mullion</u>
<b>Potable Water</b> <u>Yes</u>	<b>Power Lift</b> _____
<b>Drain</b> <u>Yes</u>	<b>Safety Equipment</b> _____
<b>Cooling Water</b> _____	<b>Communications</b> _____
<b>Compressed Air</b> _____	<b>Chalkboard (size)</b> _____
<b>Natural Gas</b> _____	<b>Tackboard (size)</b> <u>4' x 6'</u>
<b>AC/Humidity</b> _____	<b>Ventilation</b> <u>Yes</u>
<b>Fume Hood</b> _____	<b>Dust/Emissions</b> _____
<b>Vibration Control</b> _____	<b>Lighting/Darkening</b> _____

**Figure 1**

**Service Facility**

Name of Area Custodial Closets

Subheading \_\_\_\_\_

No. Required 1 ea floor, 1 ea wing No. of Occupants \_\_\_\_\_

Total Floor Area (sq. ft.) 80

Configuration (ft. x ft.) \_\_\_\_\_

Use: UG Instruction  Grad/Research \_\_\_\_\_ Pilot  Departmental

**Brief Description of Use:**

Custodial closet for storage of material and equipment used daily in building maintenance.

**Other Facilities and areas that should be in close proximity:**

(1) per floor, centrally located.

**Equipment to be located in area (existing E or new N):**

8' mop & broom rack - (N)

2 sides - 12" wide shelving, 2 shelves - (N)

floor-type slop sink equipped with hose bib & 6' trough extending into receptor for mop drainage

**General furniture requirements (seating, work tables, etc., with approximate number of stations):**

Carts

**Special Requirements (check those needed and describe those possible):**

Electrical 110V

Distilled Water \_\_\_\_\_

Potable Water Yes

Drain Yes

Cooling Water \_\_\_\_\_

Compressed Air \_\_\_\_\_

Natural Gas \_\_\_\_\_

AC/Humidity \_\_\_\_\_

Fume Hood \_\_\_\_\_

Vibration Control \_\_\_\_\_

Ceiling Height standard

Wide Door \_\_\_\_\_

Power Lift \_\_\_\_\_

Safety Equipment \_\_\_\_\_

Communications \_\_\_\_\_

Chalkboard (size) \_\_\_\_\_

Tackboard (size) \_\_\_\_\_

Ventilation \_\_\_\_\_

Dust/Emissions \_\_\_\_\_

Lighting/Darkening \_\_\_\_\_

**Figure 2**

**Service Facility**

Name of Area Custodial Room

Subheading \_\_\_\_\_

No. Required 1 No. of Occupants 2

Total Floor Area (sq. ft.) 150 - Note: may be combined with existing dept.  
Facilities for showers.

Configuration (ft. x ft.) \_\_\_\_\_

Use: UG Instruction  Grad/Research \_\_\_\_\_ Pilot  Departmental

**Brief Description of Use:**

Locker room, shower facilities, and lunch room for custodial personnel.

**Other Facilities and areas that should be in close proximity:**

Near Building Attendant's Office.

**Equipment to be located in area (existing E or new N):**

<u>Lockers - (N)</u>	<u>Coat hooks - (N)</u>
<u>Shower stalls - (N)</u>	<u>Partitioned locker, shower, and</u>
<u>Mirrors - (N)</u>	<u>Dressing area for both male and female</u>
<u>Benches - (N)</u>	
<u>Shelving - (N)</u>	

**General furniture requirements (seating, work tables, etc., with approximate number of stations):**

1 table 3' x 6'  
4 chairs  
1 wastebasket  
1 storage cabinet

**Special Requirements (check those needed and describe those possible):**

Electrical <u>110V</u>	Ceiling Height <u>standard</u>
Distilled Water _____	Wide Door _____
Potable Water <u>Yes</u>	Power Lift _____
Drain <u>Yes</u>	Safety Equipment _____
Cooling Water _____	Communications _____
Compressed Air _____	Chalkboard (size) _____
Natural Gas _____	Tackboard (size) <u>4' x 4'</u>
AC/Humidity _____	Ventilation _____
Fume Hood _____	Dust/Emissions _____
Vibration Control _____	Lighting/Darkening _____

Figure 3

**Service Facility**

Name of Area Building Attendant's Office

Subheading \_\_\_\_\_

No. Required 1 No. of Occupants 1

Total Floor Area (sq. ft.) 100

Configuration (ft. x ft.) \_\_\_\_\_

Use: UG Instruction      Grad/Research                      Pilot      Departmental                     

**Brief Description of Use:**

Building Attendant's Office.

**Other Facilities and areas that should be in close proximity:**

Adjacent to Storage Room/Supplies and Custodial Room.

**Equipment to be located in area (existing E or new N):**

Master clock system

Fire Alarm control panel

**General furniture requirements (seating, work tables, etc., with approximate number of stations):**

<u>1 desk</u>	<u>1 wastebasket</u>
<u>1 chair with arms</u>	<u>1 bookcase</u>
<u>2 side chairs</u>	<u>1 storage cabinet</u>
<u>1 file cabinet</u>	<u>1 blue print rack</u>

**Special Requirements (check those needed and describe those possible):**

Electrical <u>110V</u>	Ceiling Height <u>Standard, suspended</u>
Distilled Water <u>                    </u>	Wide Door <u>                    </u>
Potable Water <u>                    </u>	Power Lift <u>                    </u>
Drain <u>                    </u>	Safety Equipment <u>                    </u>
Cooling Water <u>                    </u>	Communications <u>Phone</u>
Compressed Air <u>                    </u>	Chalkboard (size) <u>                    </u>
Natural Gas <u>                    </u>	Tackboard (size) <u>4' x 6'</u>
AC/Humidity <u>                    </u>	Ventilation <u>                    </u>
Fume Hood <u>                    </u>	Dust/Emissions <u>                    </u>
Vibration Control <u>                    </u>	Lighting/Darkening <u>                    </u>

Figure 4

**Service Facility**

Name of Area Receiving Area - Loading Dock

Subheading See attached sketch

No. Required 1 No. of Occupants \_\_\_\_\_

Total Floor Area (sq. ft.) \_\_\_\_\_

Configuration (ft. x ft.) \_\_\_\_\_

Use: UG Instruction      Grad/Research                      Pilot      Departmental                     

**Brief Description of Use:**

Central receiving of tailgate freight for the building.

**Other Facilities and areas that should be in close proximity:**

**Equipment to be located in area (existing E or new N):**

Scissors-lift loading platform

Lighting for night deliveries

Overhead door

**General furniture requirements (seating, work tables, etc., with approximate number of stations):**

_____	_____
_____	_____
_____	_____
_____	_____

**Special Requirements (check those needed and describe those possible):**

Electrical Yes  
Distilled Water \_\_\_\_\_  
Potable Water \_\_\_\_\_  
Drain \_\_\_\_\_  
Cooling Water \_\_\_\_\_  
Compressed Air \_\_\_\_\_  
Natural Gas \_\_\_\_\_  
AC/Humidity \_\_\_\_\_  
Fume Hood \_\_\_\_\_  
Vibration Control \_\_\_\_\_

Ceiling Height \_\_\_\_\_  
Wide Door Yes  
Power Lift Yes  
Safety Equipment \_\_\_\_\_  
Communications Yes  
Chalkboard (size) \_\_\_\_\_  
Tackboard (size) \_\_\_\_\_  
Ventilation \_\_\_\_\_  
Dust/Emissions \_\_\_\_\_  
Lighting/Darkening \_\_\_\_\_

Figure 5

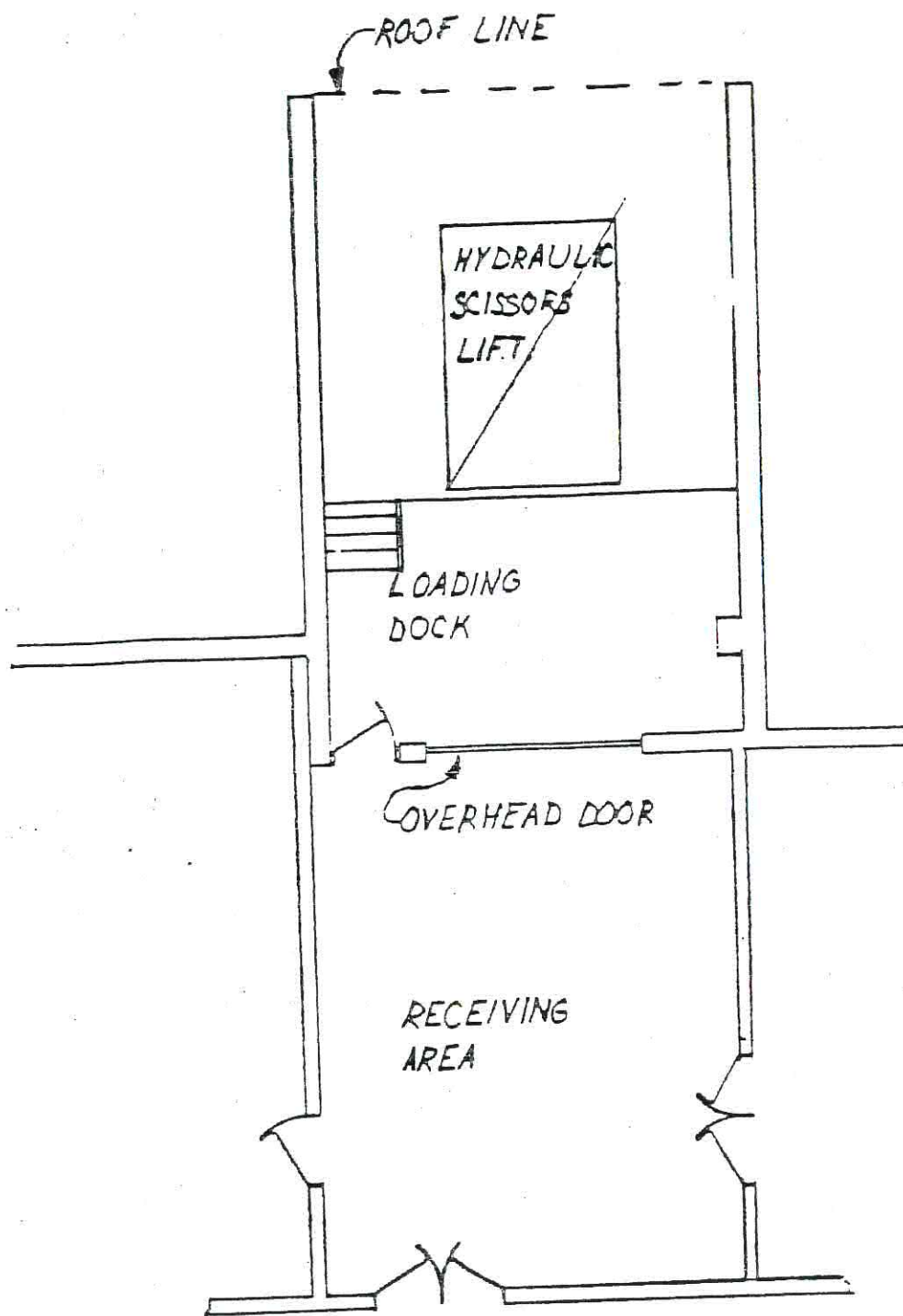


Figure 5

## **00350 Mechanical Considerations**

### **00351 General**

Areas requiring special control or requiring continuous operation should be provided with separate systems so the other system can be shut down during unoccupied hours.

Review application of variable speed or multi-speed H&V.

Provide radiation so building temperature can be maintained at 55°F without operating building air handling systems.

Review application of separate pumps for reheat boxes and for perimeter radiation.

Provide A/C for specific requirements only. Not required for general occupancy.

H&V units, exhaust fans, HHW pumps to be connected to University's Central Monitoring and Control System.

Provide Day/Night control of perimeter radiation. Provide separate control zones for distinct use areas.

Use as few equipment rooms as practical and keep equipment to be connected to the central control system as close together as possible.

Provide sensor type pneumatic controls with each receiver controller and connect for remote control point adjustment where beneficial.

Provide non-powered contacts for all alarm devices and connect to the central control system.

Provide tight shut-off dampers for outside air and relief air dampers (1% leakage at 4" S.P.) to reduce outside air being blown through the system and to reduce the possibility of the stack effect bringing in outside air through the system when not in operation.

Provide thermometer wells and sensors for: domestic water heater supply and return line, heating water supply and return mains, chilled water supply and return mains, inlet and outlet of all boilers, convertors, and chillers (chilled and condensing water lines), and any other place that knowledge of temperature would be beneficial.

Provide pressure and humidity sensors where beneficial.

Coordinate with Electrical to provide sprinklers, fire detectors, or other items as required to obtain favorable insurance rates or watchman concessions.

Design heating and electrical systems so that the proper programming of the central processing unit will allow the system to turn on cooling units and heating units before outside air is taken in.

Sequence each air handling unit system controls to first shut-off heating, second, cool with outside air, and third, to utilize mechanical cooling -all from one control device to be controlled from the central control panel.

Consider resetting the demand limiter of centrifugal chillers to lower limits from the central control panel. Make certain that chillers are provided with relays as required for remote start-stop.

Where dual chillers or boilers are used, select them for unequal percentages of the load.

Steam pressure reducing stations should be pilot-operated with capabilities to be remotely controlled where applicable.

Departmental equipment requiring access by department personnel shall not be located in building mechanical rooms, to maintain mechanical room security.

Central heating and cooling systems shall be used.

The employment of water cooled equipment which will waste potable water is prohibited.

## **00352 Criteria**

### **00352.10 Ventilation**

All units shall be capable of supplying 100% outside air for summer ventilation.

### **00352.20 Design Temperatures**

Inside air	68°F for heating
Inside air	78°F for cooling
Outside air	-10°F for heating
Outside air	86°F for cooling

### **00352.30 Exhaust Systems**

Exhaust systems shall be provided in all applicable laboratory and pilot plant areas. A quantity of exhaust taps (drops) shall be provided in laboratory areas to allow for maximum flexibility within the area. Fume hoods and chemical storage cabinets are to be exhausted separately from general room exhaust systems. Use Phoenix controls for variable volume fume hood exhaust.

### **00352.40 Chemical Storage Exhaust System**

Provide building-wide system for chemical storage cabinets. Include in base of fume hood where possible for vented storage.

### **00352.50 Humidity Control**

Humidity control shall vary proportional to outside air temperature, with direct steam humidifiers.

### **00352.60 Reheat**

Reheat shall be provided on all multi-zone units.

### **00352.70 Cooling With Outside Air**

Provision should be made for cooling with outside air when the outdoor temperature is 70°F or lower.

### **00352.80 Central Monitoring Control**

All new buildings at MTU are to be connected to the existing Central Monitoring Control System. Central Control design specifics, such as cable type, equipment to be connected, software requirements, etc., will be provided by Facilities Management.

### **Typical Points For Connection To Central Control**

#### **A. HVAC/HV Systems**

- Mixed Air Temperature
- Discharge Air Temperature
- Return Air Temperature
- Damper Control
- Hi/Low Speed

#### **B. Hot Water Heat Systems**

- Hot Water Heat Supply Temp. (one at each convector)
- Water Heat Return Temp. (one at each convector)
- Water Heat Supply Common Temp.
- Water Heat Return Common Temp.
- Water Heat Supply Temp. Reset
- Day/Night Control

#### **C. Chilled Water Systems**

- Chiller (status and control)
- Chilled Water Supply Temp.
- Chilled Water Return Temp.
- Condenser Water Supply Temp.
- Condenser Water Return Temp.
- Chilled Water Supply Reset
- Chilled Water Pump Status
- Condenser Water Pump Status
- Cooling Tower Fan Status

## **D. Miscellaneous Building Systems**

Control Air Compressor - Low Pressure  
Fire (Trouble Circuit)  
Fire (Fire Alarm Circuit)  
Domestic Hot Water Temperature  
Intercoms  
Exhaust Fans  
Sump Pump Tank - High Level  
Emergency Generator Status  
Outside Air Temperature  
Building Humidity  
Condensate Receiver - High Level

## **E. Space Temperatures**

At least one space temperature is required for each Air Handling System (preferably more) serving Critical Area Space Temperatures, e.g., Rooms with Computer Systems, Refrigerator(s), Freezer(s), or in general the rooms most likely to cool or heat the quickest.

## **F. CMCS Electrical Considerations**

Provide a spare electrical circuit in each mechanical space, and provide maintained contact switches for motor starters less than 1-1/2 HP. Provide holding contact push buttons or hand-off-autoswitches for motor starters 1-1/2 HP and larger. Interlock equipment as much as practical soon remote point can stop and start more than one piece of equipment.

### **00353 Mechanical Rooms**

The following criteria should be applied to all mechanical equipment spaces.

All mechanical rooms shall be painted.

#### **00353.10 Mechanical Room Locations**

A basement mechanical room is desirable for housing heavy and/or noise producing equipment such as water heaters, softeners, steam PRV's, condensate pumps, air compressors, utility entrances, etc.

Most buildings will require some mechanical space at a higher level and this is usually best accomplished in a penthouse. Types of equipment housed here will be air handling apparatus (usually with high fresh air requirements), building and special exhaust fans, cooling towers, water stills, etc.

All equipment items and systems must be designed and installed to operate quietly and free of vibration. Completed installation during normal operation, including starting and stopping, shall not generate any noticeable vibration in a "finished" area.

Spaces housing high heat generating equipment shall be adequately insulated and ventilated to protect adjoining areas.

Orient mechanical rooms to outside utility services.

#### **00354 Access to Equipment**

If air dampers, fire dampers, valves, etc., are located above fixed ceilings, access panels must be provided.

Proper clearances and access for maintenance of equipment, such as tube cleaning and removal on heat exchange equipment, traps, valves, air filters, water softeners, etc., must be provided. PRV stations shall be accessible from mechanical room floor. Pay particular attention to access for all main, sectionalizing, or isolating valves, as they are usually operated under emergency conditions.

#### **00355 Meters**

A meter should be provided in the incoming line of the domestic water service and in the outgoing line of the pumped condensate. Both meters shall be Badger Turbo Meters.

#### **00356 Condensate Sample Taps**

Provide a tap for sampling the condensate return. Can be on return line or on condensate receiver.

#### **00360 Electrical Considerations**

Departmental equipment requiring access by department personnel shall not be located in building electrical rooms or transformer vaults, to maintain electrical room and transformer vault security.

Lighting levels should be kept to the minimum acceptable for the use intended.

Fluorescent lights should be used wherever practical.

For high ceiling areas, metal halide and/or fluorescent shall be used.

In general, exterior lighting shall be high pressure sodium.

#### **00361 Criteria**

#### **00362 System Voltage**

MTU's main underground distribution service is at 12,470 volts in a grounded neutral "Y" configuration with two radial feeders forming a primary selective system. System protection coordination and fault current level analysis shall be completed for building with tie to MTU electrical system.

### **00363 Transformer Room**

Transformer and primary switch gear shall be located inside the building.

Normally one areaway will provide for the ventilation requirements and access to both mechanical and electrical rooms.

### **00364 Unit Substation(s)**

Building high voltage service shall be reduced to 277/480 and 120/208 volts with dry type transformer substations. The 277/480 volt substation shall be used to fluorescent lighting, motor loads, and special lab requirements.

The 120/208 volt unit substation shall be used for general receptacles and building lighting.

Distribution is from draw out breakers in the substation to fused switch distribution panels to bolt-in circuit breaker branch panels.

### **00365 Meters**

Provide watt hour meter(s) as required to measure total building electrical usage.

### **00366 Emergency Lighting/Phones**

Provide emergency lighting to be powered by an emergency generator in the event electrical power to the building fails.

Provide emergency phone jacks at each entrance and one per corridor in laboratory areas.

### **00367 Clock Systems**

Master clock systems shall be provided for classroom facilities.

Provide a clock outlet with blank cover plate in each laboratory/classroom.

### **00368 Lighting Levels**

**Exterior:** Use 50w HPS or greater or multiples thereof at entrances. No other exterior lights are required. Photocell controlled.

**Mechanical and Electrical Rooms:** Only the fixture near the door will be on 24 hrs/day. The other lights are on the emergency circuit but they are switched.

**Stairways:** One 34-watt tube (4') per landing. Every other light to be on the emergency circuit. Keyed switch to control the others. Photocell control where natural light is available.

**Corridors:** Single lamp parabolic fixtures (PM 3 140, Lithonia) spaced at 16' intervals. Emergency lighting spaced at 48' intervals. For extra wide corridors use lighting recommendation values in MTU Lighting Standards.

Photocell control on corridors that will receive natural lighting in the daytime. Keyed switch to control non-emergency corridor lights. Provide computer control point for all non-emergency corridor lighting except in areas occupied 24 hrs/day and non-emergency stairway lighting.

**Rest Rooms:** Provide one (1) centrally located 7-watt PL lamp fixture on emergency circuit to be on 24 hrs/day. Other lighting is to be controlled by occupancy sensor, wall mounted which essentially acts as a timer with 12-minute delay. Unenco SOM-500 or watt stopper model.

**Exit Signs:** Use 2 watt LED type.

**Vestibules:** Fluorescent or HPS (50 watt or greater or multiples). Photocell controlled where natural light is available.

**Audio/Visual Rooms:** Option 1: 2 level, 34 watt fluorescent at 5 FC & 50 FC maintenance. Option 2: 50 FC fluorescent from 34 watt lamps and 5 FC from PL-7's.

**General Considerations:**

No indirect lighting to be provided.

1 or 2 lamp fixtures to be used.

Parabolic fixtures preferred with large cubes and silver reflectors. (Lithonia 2 PM 3 240, 2 PM 3 x 240, PM 3 140), Metallux.

Use 4 ft., T-8 lamps in 3500°K color spectrum suitable for application with electronic ballasts.

Where recessed downlighting is required, use 7 watt PL lamps in elliptical reflector assemblies without any **additional** lenses on fixture.

Energy efficient electronic ballasts. (If electronic ballasts are used, emergency generator should have surge-limiting device).

Review wall mounted occupancy sensors for offices, storage areas and other applications.

Review ceiling mounted occupancy sensors for classrooms, labs and large rooms. Make provisions in wiring for future installations.

**Michigan Technological University  
Lighting Standards Established in 1980**

<u>Location</u>	<u>Foot-candle Level</u>	<u>Remarks</u>
General Office	45-55	At primary work station
Classrooms	45-55	
General Labs	45-55	
Special Labs	45-100	As required by task
Lecture Rooms	30-50	
Corridors, Stairwells	5-10 ave. 1 min.	As required for Safety; Usually 1/3 or 1/2 of original design is enough
Restrooms, Washrooms	20 ave.	5 FC Min.
Conference Tables	30	10 FC Background
Secretarial Desks	50	With Aux Task Lighting
Secretarial Desks	60-70	Without Aux Task Lighting
Accounting, Clerical	60-70	
Files	30	Over open drawers
Drafting	60	Part-time
Drafting	80	Full-time
Waiting, Lounge Area	10-15	
Kitchens	50 ave.	Non-uniform distribution
Cafeteria	20	
Snack Bar	20	
Shops	50-100	
Storage Rooms	10	
Foundry	50	On task
Computer Rooms	40-70	Depending on task
Library - Study Areas	45-55	
Library - Book Stacks	20-30	

Adopted from Federal Energy Administration Guidelines, American National Standard Institute Recommendations, Illumination Engineering Society Handbook and Governor of Michigan Directives of 1977.

**Figure 6**

**00400 Safety Considerations**

**00410 General**

Fire hose cabinets will have a 2-1/2 inch National Standard thread coupling.

Building Siamese connector shall be 2-1/2 inch x 2-1/2 inch x 6, with double clapper valves, brass plugs, with reducer to match City of Houghton Fire Department hoses.

All cabinets in one building with cylinder locks will be keyed identically.

Fire extinguisher cabinets shall be provided by the contractor.

Fire extinguishers (type specified by MTU) will be required in laboratories and other rooms. Such Extinguishers will be wall mounted by room exit doors. These extinguishers will be furnished by Owner and installed by MTU unless otherwise specified.

Building fire alarm systems are to be closed circuit, non coded electrically supervised, general alarm type. Annunciator panels are to be located in the lobby or Fire Department entry point. Annunciator panels shall be of the graphic type showing building outline, the location of the devices, type of device and floor or elevation.



**APPENDIX A**

**Facilities Management**

**Michigan Technological University**

**Houghton, Michigan**

**November, 1989**

**Value Specification General Outline**

**(Equal Values by Stockham, Powell, or Milwaukee May Be Used)**

**Hi-Pressure Steam Service (50-125 PSIG)**

**Boiler Feedwater (250 PSIG, 2500 F. )**

<u>Gate Valves</u>	<u>Rating PSI</u>	<u>Type</u>	<u>Approved Manufacturer No.</u>
0 - 2"	200 STM, 400 WOG	Bronze, screwed	Crane 424 NIBCO T-174-SS
2-1/2" - 12"	250 STM, 500 WOG	Iron body, flanged bronze trim	Crane 7E NIBCO F-667-0
1-1/2" - 12"	300 STM	Cast steel, butt welded	Crane 33-1/2 XU
 <u>Globe Valves</u>			
0 - 2"	200 STM, 400 WOG	Bronze, screwed	Crane 70E NIBCO T-276-AP
2-1/4" - 4"	250 STM, 500 WOG	Cast steel, flanged	Crane 21E

## APPENDIX A

### Lo-Press Steam (0-50 PSIG) and Condensate Service

<u>Gate Valves</u>	<u>Rating PSI</u>	<u>Type</u>	<u>Approved Manufacturer No.</u>
0 - 2"	150 STM, 300 WOG	Bronze, screwed	Crane 431 NIBCO T-135
2-1/2" - 12"	125 STM, 200 WOG	Iron body, flanged bronze trim	Crane 465-1/2 NIBCO F-617-0
<u>Globe Valves</u>			
0 - 2"	150 STM, 300 WOG	Bronze, screwed	Crane 7 NIBCO T-235
2-1/2" - 4	125 STM, 200 WOG	Iron body, flanged bronze trim	Crane 351 NIBCO F-718-B
<u>Check Valves</u> (except for pump discharge)			
0 - 2"	200 STM, 400 WOG	Bronze, screwed Swing-check	Crane 36 NIBCO T-473
2-1/2" and up	125 STM, 200 WOG	Iron body, flanged Swing-check	Crane 373 NIBCO T-F-918
<u>Check Valves</u> (pump discharge)			
0 - 3"	200 STM, 400 WOG	Bronze, screwed Lift-check	Crane 218

## APPENDIX A

### Compressed Air, Chilled Water, Condenser Water

#### Domestic Water Service (Up to 125 PSI)

#### Heating Hot Water Service (Up to 250° F.)

<u>Ball Valves</u>	<u>Rating PSI</u>	<u>Type</u>	<u>Approved Manufacturer No.</u>
0 - 2"	400 WOG	Bronze, screwed	Apollo 70-100 NIBCO T-560-BR-Y- 20

#### Gate Valves

2-1/2" - 3"	150 STM, 300 WOG	Bronze, screwed	Crane 431 NIBCO T-135
4" - 6"	125 STM, 200 WOG	Iron body, flanged bronze trim	Crane 465-1/2 NIBCO F-617-0

#### Balancing Valves

0 - 2"	175 WOG	Semi-steel body, screwed adj. tops, removable handle, 2500 F. seals	Dezurik 118S
2-1/2" and up	175 WOG	Same as above, except flanged	Dezurik 118F

### Fuel Oil Service

<u>Plug Valves</u>	<u>Rating PSI</u>	<u>Type</u>	<u>Approved Manufacturer No.</u>
0 - 1-1/2"	150 STM, 200 WOG	Lub. Plug, screwed	Homestead 601, 611
2" - 8"	150 STM, 200 WOG	Lub. Plug, flanged	Homestead 612

## APPENDIX A

### Waterworks

#### For Direct Burial

<u>Gate Valves</u>	<u>Rating PSI</u>	<u>Type</u>	<u>Approved Manufacturer No.</u>
2" - 12"	300 Test 175 Working	Mech. Joint ends, inside screw, non-rising stem	Traverse City Iron Works Fig. A-230-M/MJ-MJ-330-NRS Class C, 300 Series (Cat. Pg. 32)
14" - 16"	300 Test 150 Working	Same as above	Same as above

#### For Use in Vaults

2" - 12"	300 Test 175 Working	Flanged ends, rising stem	Traverse City Iron Works Fig. A-237-F/FF-300-R. S. Class C, 300 Series (Cat. Pg. 34)
14" - 16"	300 Test 150 Working	Same as above	Same as above

#### GENERAL NOTES:

These outline specifications are based upon the following manufacturers' catalogs.

Crane Cat. No. 60, Copyright 1960.  
Lunkenheimer Cat. No. 66, Copyright 1966.  
Traverse City Iron Works, Cat. No. 16.  
Homestead Ref. Book 40-1  
Apollo Cat. No. BV-1076.

- All valves shall be provided with teflon impregnated braided packing.
- All gate and globe valves to be provided with rising stems, except water-works valves for direct burial use.

## APPENDIX B

**Materials Listing**  
**Facilities Management**  
**Michigan Technological University**  
**Houghton, Michigan**  
**November 1989**

To facilitate maintenance while carrying a minimum replacement parts inventory, we have, to an extent, standardized our utility systems. The following is a list of some of the auxiliary equipment manufacturers which have been included. In each case the first name is that of the manufacturer of the equipment most frequently used in the building systems and preferred by Michigan Technological University.

### ARCHITECTURAL

<u>Items</u>	<u>Manufacturers</u>
Access Panels	Milcor
Locks	Best or Corbin Russwin, Mortise type
Lock-Cylinder and Keying	Best 7 pin "D" or "A" keyway, combined
Closers	LCN 4040, Cush-N-Hold
Hinges	Lawrence Hager - ball bearing, stainless steel pin, N. R. P.
Manhole Covers	Traverse City, Neenah Foundry, Name of service cast in - Electrical, Communication, Sanitary, Storm
Paint	Nelson, PPG, Sherwin-Williams, Glidden
Ceiling Suspension Systems	Chicago Metallic Corp.
Panic Bars	Von Duprin 99
Roof	Adhered or mechanically fastened, Carlisle, Trocal
Aluminum Doors	Tublite Monumental, Kawneer Ruline 350
Holder	Glen Johnson GJ 100
Windows, Aluminum	Thermo-break, EFCO-Wausa
Toilet Partitions	Ceiling mount

APPENDIX B (Continued)

ELECTRICAL

<u>Items</u>	<u>Manufacturers</u>
Motors	Lincoln, Baldor, Louis Allis, General Electric
Power Panels	Square D - QMB, Cutler-Hammer, General Electric - QMR
Transformers	Square D, Cutler-Hammer, Hevi Duty, General Electric, Olson
Safety Switches	Square D, Cutler-Hammer, General Electric
Outlets and Switches	Specification Grade - Hubbell, Pas & Seymour, Arrow-Hart, General Electric
H. V. Switchgear	S & C, Square D, Cutler-Hammer, General Electric
Clocks, Signal System	National Time, Simplex, Edwards
Conductors	Copper (98% conductivity)
Starters	Square D, Cutler-Hammer, General Electric, Allen-Bradley
Fluorescent Lighting Fixtures	Metolax, Hollophane, Lithonia, Daybrite, Rudd
Ballasts	Advance, Universal, General Electric, High Power Factor, Sound Rating A Energy Saving Electronic
Contractors	Asco, Square D, Onan, Cutler-Hammer, Allen-Bradley
Emergency Generators	Kohler, Onan
HV Cable	Shielded, EP Insulated, KV, anit-treeing

APPENDIX B

PLUMBING

<u>Items</u>	<u>Manufacturers</u>
Floor Drains	Josam, Zurn, J. R. Smith
Roof Sumps	Josam, Zurn, J. R. Smith
Water Closets	American Standard, Crane, Kohler
Flush Valves	Crane, Sloan, Zurn
Seats	Olsonite, Church
Lavatories	American Standard, Crane, Kohler
Urinals	American Standard, Crane, Kohler
Shower Heads	Bradley, Milwaukee's "Concord", Chicago
Shower Mixing Valves	American Standard, Crane, Kohler
Water Coolers	Halsey Taylor, General Electric, Osis
Sinks	American Standard, Crane, Kohler
Service Sinks	American Standard, Crane, Kohler
Laundry Trays	American Standard, Crane, Kohler
Relief Valves with Hand Levers	Crane, Watts, Consolidated

HEATING - STEAM

Temperature Control	Johnson Controls, Honeywell
Zone Control	Johnson Controls, Honeywell
Convectors	Trane
Relief Valves	Crane, Kunkle, Consolidated
Strainers	Yarway, Trane, Armstrong, Crane
Thermometers	Trerice, Ashcroft
Pressure Regulating Valves	Fisher, Leslie
Sump Pumps	Aurora, Union, Fairbanks Morse

## APPENDIX B

### HEATING - STEAM

<u>Items</u>	<u>Manufacturers</u>
Condensate Pumps	Aurora, Nash, Skidmore, Chicago
Gauges	Ashcroft, Terice
Self-Operating Control Valves	Fisher, Leslie
High Pressure Traps	Bestobell, Armstrong, Trane
Low Pressure Traps	Bestobell, Armstrong, Trane
Convactor Traps	Armstrong, Trane
Steam Heating Specialties	Crane, Mueller, Hoffman
Expansion Joints	Yarway, gun-packed type

### HEATING - HOT WATER

Baseboard Radiation	Trane, Sterling, Slant Finn
Domestic Hot Water Tanks	Paterson, A. O. Smith, Aerco
Zone Control	Johnson Controls, Honeywell
Hot Water Circulating Pumps	Aurora, Taco
Hot Water Heating Relief Valves with Hand Lever	Crane, Kunkle, Consolidated
Heat Exchangers	Bell & Gossett, Armstrong
Air Vents	Hoffman
Expansion Tanks with Airtrol Fittings	Bell & Gossett, Amtrol
Forced Flo Convectors	Trane
Hot Water Heating Specialties	Bell & Gossett

## APPENDIX B

### HEATING - GENERAL

<u>Items</u>	<u>Manufacturers</u>
Controls (pneumatic)	Johnson Controls, Honeywell
Grilles and Registers	Hart & Cooley, Tuttle & Bailey, Titus
Room-type Heating and Ventilating Units	Trane, Modine, McQuay
Finn Pipe Radiation	Trane, Slant Finn, McQuay
Unit Heaters	Trane, Modine, McQuay
Convectors (recessed)	Trane

### Ventilating

Fans	Trane, Buffalo, Joy
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### Fire Protection

Fire Hydrants	Traverse City Iron Works
Wall Hydrants	Woodford
Water-type Fire Extinguishers (CO <sup>2</sup> cartridge operated)	General Fire Extinguisher Corp.
Fire Hose Cabinets	General Detroit, W. D. Allan
Gate Valves	Traverse City Iron Works
Valve Boxes	Traverse City Iron Works
Sprinkler Heads	Grinnell

### Piping

Underground Steam Lines	U-con or Concrete Mini-tunnel
Pipe Covering	Johns-Manville, Certain-Teed
Strainers	Crane, Trane, Armstrong

APPENDIX B

Water Conditioning

<u>Items</u>	<u>Manufacturers</u>
Existing Service Contract (boiler)	Betz Corporation

Elevator

Otis Elevator Co.  
Northwestern Elevator Co.

Air Conditioning

Trane  
Carrier  
Liebert

## APPENDIX C

### Mechanical Equipment Insulation Standards

Facilities Management

Michigan Technological University

Houghton, Michigan

April 30, 1981

Attached are standards for mechanical equipment minimum insulation thickness to be used on new construction, as well as remodeling and renovation. The recommended thickness listed set forth the maximum acceptable system thermal losses.

Alternative insulations in any thickness are acceptable provided their thermal efficiencies equal or exceed these standards.

The standards do not address any of the following factors or requirements:

- vapor barrier
- noise reduction
- type of finish (paper, foil, metal coverings, etc.)
- mechanical strength
- service temperature
- quick removable types (for valves, expansion joints and fittings)

For applications not covered by these standards, ASHRAE 90-75 should be adhered to.

Insulation densities are suggested but they can vary depending on mechanical strength and service temperature requirements.

APPENDIX C

Michigan Technological University  
Mechanical Equipment Insulation Standards

Piping  
Minimum Insulation Thickness  
4# Fiberglass, R=4.3 @ 75%

National Pipe Size	TYPE OF SERVICE					
	High Press. Steam	Low Press. Steam	Condensate	Heating Hot Water	Domestic Hot Water	Low Temp. Piping
Up to 3/4"	1 ½	1	1	1	1	1
1" to 1 ½"	2	1 ½	1 ½	1 ½	1	1
2" to 3 ½"	2 ½	2	2	2	1 ½	1 ½
4" to 5"	3	2 ½	2	2	2	1 ½
6" and Up	4	3	2 ½	2	2	1 ½

Piping  
Alternate  
Minimum Insulation Thickness  
Calcium Silicate, R=2.7 @ 75° F

National Pipe Size	TYPE OF SERVICE		
	High Press. Steam	Low Press. Steam	Condensate
Up to 3/4"	2 ½	1 ½	1 ½
1" to 1 ½"	3	2 ½	2 ½
2" to 3 ½"	4	3	3
4" to 5"	5	4	3
6" and Up	6	5	