



- HOME
- ABOUT US
- PROJECTS
- MAPS & DETOURS
- MASTER PLANNING
- POLICIES & PROCEDURES
- SUSTAINABILITY
- SAFETY

- FOR U-M CLIENTS
- FOR VENDORS
- FOR U-M AEC STAFF

OUT TO BID

DESIGN GUIDELINES

- CODES & REGULATORY AGENCIES
- DESIGN DELIVERABLES
- SUSTAINABILITY
- SPECIAL INSTRUCTIONS TO DESIGNERS
- SPECIAL BUILDING AREAS
- OFFICE SPACE
- TECHNICAL SECTIONS
- STANDARD DETAILS
- MASTER SPECIFICATIONS
- PREFERRED MANUFACTURERS
- HEALTH SYSTEM PROJECTS
- EFFECTIVE DATE

BUILDING COMMISSIONING

CONTRACTS & AGREEMENTS

CONTRACTOR RESOURCES

OTHER LINKS

DESIGN GUIDELINES

INTRODUCTION TO THE U OF M DESIGN GUIDELINES

This web site contains Design Guidelines for the design and construction of facilities at the University of Michigan. The Design Guidelines that are in effect at the time that schematic design begins for a given project shall be used by all design professionals (architects, engineers, interior designers) in the preparation of construction documents for the project. The purpose of the Design Guidelines is to assure maximum quality and value in construction projects at the University of Michigan, through uniformity, system or component quality, compatibility, sustainability, functionality, and ease of maintenance. These Design Guidelines are intended to provide general direction to design professionals as a general rule for most circumstances. With the



wide variety of facilities, varying life expectancies and program requirements, these Guidelines have to be specifically and correctly applied to each project by the design professional. These Design Guidelines do not replace professional design analyses, nor are they Contract Specifications. We expect the design professional to conduct independent evaluations for each project. Applications of proven technologies and systems to provide cost effective alternate design concepts are encouraged. Deviation from the design guidelines and standard details is discouraged. However, the University recognizes that there will be times when deviations from these Design Guidelines may be appropriate on some projects, and in those instances, the design professional is expected to proactively and in writing, approach the University design manager for written approval to deviate from the Guidelines.

Throughout these documents reference is made to the A/E's contact with the University as the Design Manager. This title is defined as the Owner's Representative during the design and construction document phases.

Suggestions for improving these Design Guidelines should be addressed to UMDesignGuide@umich.edu in the Architecture, Engineering and Construction Department. Revisions will be issued on a periodic, as-needed basis.

These Design Guidelines are *only* for use by consultants in connection with work performed for the University of Michigan. They are to be used as a guide in the preparation of design documents for University of Michigan construction projects. They are not intended to relieve the designers from their responsibility to comply with applicable codes and other contract obligations.

DESIGN GUIDELINES

- [Design Deliverables](#)  contains a matrix describing information required from contracted designers at each phase in the design process.
- [Codes and Regulatory Agencies](#)  is an annotated list of all applicable building codes and standards for the University of Michigan.
- [Sustainability for Design and Construction](#) provides criteria for sustainable design and LEED requirements.
- [AEC Sustainability Master Plan](#) is a comprehensive document which communicates the methodology Architecture Engineering and Construction is employing to improve building design and construction sustainability at the University of Michigan.
- [Special Instructions to Designers](#) contains instructions on a wide variety of general, cross-discipline topics, including codes to be followed, and building commissioning.
- [Special Building Areas](#) contains design criteria and design approach specific to certain building or room types.
- [Office Space Guidelines](#) enable General Fund administrative and academic units to decide more effectively how to assign and use office space when planning renovations and new construction or responding to pressing space needs. The guidelines provide space-per-person recommendations by position type, which are based on recent construction projects at the University and guidelines used by other universities and in the private sector.

Technical Standards

- [Technical Sections](#) (CSI Divisions 1 -14, 21-23, 26-28) contains system specific design criteria and design approach. Sections are divided by CSI specification section number.
- [Standard Details](#) express typical University requirements, and thus should be used in place of the equivalent A/E detail. Professional judgment is required to make Standard Details project specific.
- [Master Specification](#)

Other References

- [Preferred List of Manufacturers](#) contains specific manufacturers that are acceptable for use on U of M projects This section is also divided by CSI number.
- [UM Hospitals and Health Centers Facilities Planning and Development web page](#) contains design guidelines that are specific to University of Michigan Hospitals and Health Centers projects.
- [Effective Date](#) - Compiled Design Guidelines by Month and Year

Contact Us



- HOME
- ABOUT US
- PROJECTS
- MAPS & DETOURS
- MASTER PLANNING
- POLICIES & PROCEDURES
- SUSTAINABILITY
- SAFETY

- FOR U-M CLIENTS
- FOR VENDORS
- FOR U-M AEC STAFF

OUT TO BID

DESIGN GUIDELINES

CODES & REGULATORY AGENCIES

DESIGN DELIVERABLES

SUSTAINABILITY

SPECIAL INSTRUCTIONS TO DESIGNERS

SPECIAL BUILDING AREAS

OFFICE SPACE

TECHNICAL SECTIONS

STANDARD DETAILS

MASTER SPECIFICATIONS

PREFERRED MANUFACTURERS

HEALTH SYSTEM PROJECTS

EFFECTIVE DATE

BUILDING COMMISSIONING

CONTRACTS & AGREEMENTS

CONTRACTOR RESOURCES

OTHER LINKS

CODES & REGULATORY AGENCIES

[Codes and Regulatory Agencies](#) is an annotated list of all applicable building codes and standards for the University of Michigan. Issued August 2014.

Previous version of (SID-F) Codes and Regulatory Agencies, issued [January 2014](#).

U-M Gateway | Business & Finance | Facilities & Operations

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Design by Michigan Creative

326 East Hoover, Ann Arbor, MI 48109-1002

Phone: (734) 763-3020

[Contact Us](#)



CODES AND REGULATORY AGENCIES

Introduction

The University of Michigan is a State of Michigan constitutional corporation, governed by a Board of Regents elected by the People of the State of Michigan and has a great deal of regulatory autonomy. It is exempt from local building and zoning ordinances and subject to State of Michigan laws and regulations that are clearly intended to apply to universities. In lieu of local building ordinances and State of Michigan laws and regulations that do not apply at the University, the University chooses to require that new construction adhere to a number of well-established building codes and standards, as listed in this Section.

Regardless of origin or enforcing agency, all of the applicable building codes and standards listed below are to be followed. Note, for instance, that compliance with the State of Michigan Bureau of Fire Safety rules for schools and/or dormitories does not eliminate the need to also comply with the Michigan Building Code, and that compliance with the 2010 Americans with Disabilities Act does not eliminate the need to comply with the barrier free provisions of the Michigan Building Code. Additional codes may apply for particular situations, such as for Medical Center construction; these are to be considered on the case-to-case basis. Many times adherence to narrow scope codes and/or standards is required by the general codes listed below.

New editions of building codes are published from time to time. For each project, the edition of building codes cited in this section from which the University of Michigan is listed as the “Enforcing Agency” is to be as follows:

The edition of building codes is to be as listed in this section as of the beginning of the design development phase of a project unless construction documents are submitted to the University for final review more than a year after adoption of the new version of the code. If more than one year has transpired between adoption of the new code and submission of construction documents to the University for final review, the edition of the building codes listed in this section as of submission of construction documents applies.

The University employs building inspectors, who are the authority having jurisdiction on all University property. Refer to each code dictionary for authority having jurisdiction contact information.

**Table of Contents**

Introduction.....	1
Table of Contents.....	2
Building Codes for University of Michigan	5
Michigan Building Code.....	5
Michigan Residential Code.....	6
ADA Standards for Accessible Design.....	6
State of Michigan Dormitory Fire Safety Rules for Schools, Colleges and Universities	7
State of Michigan Fire Safety Rules for Schools, Colleges and Universities	7
State of Michigan Human Services for Child Care in a Child Care Center.....	8
Michigan Rehabilitation Code for Existing Buildings.....	8
International Fire Code	8
State of Michigan Occupational Safety and Health Standards (MIOSHA).....	8
United States Occupational Safety and Health Standards (OSHA).....	9
State of Michigan Elevator Code	9
State of Michigan Mechanical Code.....	9
State of Michigan Plumbing Code	10
NFPA 13 –Sprinkler Systems.	10
NFPA 99C – Gas and Vacuum Systems	10
State of Michigan Electrical Code	10
NFPA 72 – National Fire Alarm Code with Appendix E	11
Guide for the Care and Use of Laboratory Animals	12
State of Michigan Rules for Soil Erosion & Sedimentation Control	12
State of Michigan Issued NPDES Permit	12

State of Michigan Contaminated Soil and Groundwater	13
State of Michigan Leaking Underground Storage Tanks	14
State of Michigan Underground Storage Tanks (UST)	14
State of Michigan Aboveground Storage Tanks (AST)	15
Emergency Generators	15
Boilers	16
Chemical Storage	17
Building Standards for University of Michigan construction that are required for subsequent licensing of the facility	17
State of Michigan Department of Licensing and Regulatory Affairs, Division of Health Facilities and Services	18
Center for Medicare and Medicaid Services (CMS)	18
The Joint Commission Requirements for Accreditation of Health Care Facilities	19
State of Michigan Department of Licensing and Regulatory Affairs, Bureau of Health Systems, Radiation Safety Section	19
State of Michigan Department of Licensing and Regulatory Affairs, Bureau of Fire Services (BFS)	19
ASHRAE / ASHE Standard 170-2013 “Ventilation of Health Care Facilities”	19
University of Michigan Leased Health Care Facilities	20
Toxic and/or Hazardous Materials at University of Michigan Health Care Facilities	20
Aviation, Pharmacy, Psychology, and Pathology, etc.	20
State of Michigan Rules for Construction or Renovation of Food Service Facilities	20
State of Michigan Rules for Construction or Renovation of Swimming Pools	21
State of Michigan Department of Environmental Quality (MDEQ)	21
United States Environmental Protection Agency (USEPA)	22
University of Michigan Buildings That Contain Instructional Space	23
University of Michigan Buildings That Contain Dormitory Space	24
University of Michigan Buildings That Contain Child Care Space	24



University of Michigan Buildings That Are Inpatient & Health Care Facilities	24
University of Michigan Buildings That Contain Ambulatory Surgery Centers.....	25
University of Michigan Buildings That Contain Outpatient Dialysis.....	25



Building Codes for University of Michigan

Michigan Building Code 2009 (adopted March 9, 2011) promulgated by the State of Michigan Department of Licensing and Regulatory Affairs Bureau of Construction Codes. Including rule 408.30401 Rule 401 as printed on the interior cover of the Michigan Building Code.

By local rule, the following exceptions/modifications are applied to the Michigan Building Code article 716.5.3, article 907.5.2.3.4, and article 1008.1.9.10:

Article 716.5.3 add exception number 6:

Exception 6. In other than I or H occupancies or University of Michigan Hospitals and Health Center owned and/or occupied facilities, when equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, smoke dampers are not required at shaft enclosures unless specifically required by other sections of the code. Instead, provide smoke dampers at locations and to function as prescribed in the 2009 edition of NFPA 90A - 'Standard for the Installation of Air-Conditioning and Ventilating Systems'.

Article 906.1 exception under item 1 is not permitted to be used.

Article 907.5.2.3.4 Group R-2 reference the following interpretation of the use of the word "capability":

In the sentence "all dwelling units shall be provided with the capability to support visible alarm notification appliances...". Capability of the fire alarm system shall be addressed by the spare capacity already required in all U of M fire alarm circuits and fire alarm panels. This spare capacity in the circuits (raceways, and installed conductoring), shall be available immediately after the fire alarm system is commissioned. The spare capacity at the panel, may be in the form of power supplies sized for the expansion, and/or in the form of sufficient (spare) mounting space in the panel for the additionally needed power supplies. Refer to U of M Design Guideline and master specifications for spare capacity requirements.

Article 1008.1.9.10 add the following:

"Exception 4. In existing buildings, selected doors on stair enclosures shall be permitted to be equipped with hardware that prevents reentry into the interior of the building, provided that egress is maintained and:

- (a) There are at least two levels where it is possible to leave the stair enclosure; and
- (b) There are not more than four stories intervening between stories where it is possible to leave the stair enclosure; and
- (c) Reentry is possible on the top or next to top story permitting access to another exit; and
- (d) Doors permitting reentry are identified as such on the stair side of the door; and
- (e) Doors not permitting reentry shall be provided with a sign on the stair side indicating the location of the nearest door, in each direction of travel, permitting reentry or exit.
- (f) Doors that prevent reentry from the stair must be capable of being unlocked simultaneously without unlatching upon a signal from the fire command center, if present, or a signal by emergency personnel from a single location inside the main entrance to the building

Chapter 32 Encroachments into the Public Right of Way: Within the public right of way adhere to City of Ann Arbor standards and specifications refer to the following web site for requirements:



http://www.a2gov.org/government/publicservices/project_management/privatedev/Pages/StandardSpecificationsBook.aspx

The following regulations take precedence over conflicting requirements in the Michigan Building Code:

Chapter 13 Energy Efficiency comply with ASHRAE Standard 90.1 2007 – Effective February 1, 2009. Refer to University Design Guidelines for additional requirements.

State of Michigan Elevator Code.

State of Michigan Mechanical Code 2012 and Michigan Plumbing Code 2012.

State of Michigan Electrical Code incorporating “NFPA 70 --National Electrical Code”, 2011 edition with University of Michigan modifications.

“NFPA 13 2007 -- Sprinkler Systems”.

“NFPA 45 2004-- Fire Protection for Laboratories Using Chemicals”.

“NFPA 72 -- National Fire Alarm Code”, 2007 edition with University of Michigan modifications.

“Guide for Care and Use of Laboratory Animals” promulgated by US Dept of Health & Human Services.

Enforcing Agency —

University of Michigan Architecture, Engineering and Construction.

Enforcing Agency for Barrier Free —

State of Michigan Department of Licensing and Regulatory Affairs Bureau of Construction Codes. Variances from barrier free design provisions must be requested of the Barrier Free Design Board once approved by the University of Michigan Architecture, Engineering and Construction for submission.

Web site for Michigan Barrier Free Design Board:

http://www.michigan.gov/lara/0,4601,7-154-35299_10575_17394_17569-46778--,00.html

Michigan Residential Code 2009 (adopted March 9, 2011) promulgated by the State of Michigan Department of Licensing and Regulatory Affairs Bureau of Construction Codes. Including rule 408.30401 Rule 401 as printed on the interior cover of the Michigan Building Code.

Enforcing Agency —

University of Michigan Architecture, Engineering and Construction.

ADA Standards for Accessible Design 2010 (adopted March 9, 2011) As required to comply with Section 504 of US Rehabilitation Act of 1973 Title II of Americans with Disabilities Act of 1990 and updated September 15, 2010. Also note that the University maintains a space-by-space database of non-compliance. Contact Architecture, Engineering and Construction for database information. Notice of corrections are to be reported to Architecture, Engineering and Construction for the purpose of updating the database.



State and local government facilities must follow the requirements of the 2010 Standards, including both the Title II regulations at 28 CFR 35.151; and the 2004 ADAAG at 36 CFR part 1191, appendices B and D. In the few places where requirements between the two differ, the requirements of 28 CFR 35.151 prevail.

Enforcing Agency —

All federal agencies (on complaint basis) for U.S. Rehabilitation Act of 1973, U.S.

Department of Justice and Architectural and Transportation Barriers Compliance Board (on complaint basis) for Americans with Disabilities Act.

Web site for 2010 ADA: <http://www.ADA.gov>

State of Michigan Dormitory Fire Safety Rules for Schools, Colleges and Universities (filed December 21, 1999) promulgated by the State of Michigan Bureau of Fire Services (incorporating by reference NFPA 101 – Life Safety Code 1997). Note that this standard applies only to fire compartments of buildings which contain dormitories. A listing of Ann Arbor campus buildings that contain dormitory space is included at the end of this section.

Enforcing Agency —

State of Michigan Department of Licensing and Regulatory Affairs

Bureau of Fire Services, Fire Safety Plan Review Division

525 W Allegan 4th Floor

Lansing, MI. 48913-0001

(517) 241-8847

Administrative rules web site: http://www7.dleg.state.mi.us/orr/Files/AdminCode/965_2011-003LR_AdminCode.pdf

Application forms under Bureau Fire Services:

http://www.michigan.gov/documents/dleg_bccfs_plrvwinsp_87149_7.pdf

State of Michigan Fire Safety Rules for Schools, Colleges and Universities (filed December 14, 1989) promulgated by the State of Michigan Bureau of Fire Services (incorporating by reference NFPA 101 – Life Safety Code 1997). Note that this standard applies only to fire compartments of buildings which contain instructional space (classrooms and/or instructional laboratories). A listing of Ann Arbor campus buildings that contain instructional space is included at the end of this section.

Enforcing Agency —

State of Michigan Department of Licensing and Regulatory Affairs

Bureau of Fire Services, Fire Safety Plan Review Division

525 W Allegan 4th Floor

Lansing, MI. 48913-0001

(517) 241-8847

Administrative rules web site: http://www7.dleg.state.mi.us/orr/Files/AdminCode/964_2011-002LR_AdminCode.pdf

Application forms under Bureau of Fire Services:



http://www.michigan.gov/documents/dleg_bccfs_plrvwinsp_87149_7.pdf

State of Michigan Human Services for Child Care in a Child Care Center promulgated by the State of Michigan Human Services. Note that this standard applies only to fire compartments of buildings which contain child care centers. A listing of Ann Arbor campus buildings that contain Child Care Centers is included at the end of this section.

Enforcing Agency —

State of Michigan Department of Human Services

PO Box 30759

Lansing, MI. 48909-8150

(517) 241-2488

Administrative rules:

http://michigan.gov/documents/dhs/Child_Care_Center_Rules_419095_7.pdf

State of Michigan Department of Licensing and Regulatory Affairs

Bureau of Fire Services, Child Care Section

PO Box 30700

Lansing, MI. 48909

Application form for Child Care Plan Review:

http://www.michigan.gov/documents/cis/BFS13_child_care_app1_172799_7.pdf

Michigan Rehabilitation Code for Existing Buildings 2009 (adopted March 9, 2011) promulgated by the State of Michigan Department of Licensing and Regulatory Affairs Bureau of Construction Codes. Including Rule R408.30551 Rule 551 and R408.30552 Rule 552 as printed on the interior cover of the Michigan Rehabilitation Code for Existing Buildings.

Enforcing Agency —

University of Michigan Architecture, Engineering and Construction.

International Fire Code 2009 (adopted March 9, 2011) promulgated by the International Code Council and as referenced in the Michigan Building Code.

Enforcing Agency —

University of Michigan OSEH Fire Marshal.

1239 Kipke Dr.

Ann Arbor, MI. 48109-1010

734) 615-2718

State of Michigan Occupational Safety and Health Standards (MIOSHA) (filed many different dates) Contact U of M Department of Occupational Safety and Environmental Health for projects involving toxic and/or hazardous materials.

Contact UM Department of Occupational Safety and Environmental Health (OSEH) for projects affecting worker safety issues, such as work conditions resulting in exposure conditions to air



contaminants, noise, ergonomic hazards, bloodborne pathogens, ionizing or nonionizing radiation, and potential for exposure to worker falls, electrical hazards, excavations.

Additional information is at web site: http://www.oseh.umich.edu/pdf/guideline/guide_ep002.pdf

Enforcing Agency —

Michigan Department of Licensing and Regulatory Affairs
MIOSHA
P.O. Box 30643
Lansing, MI 48909
(517) 322-1814

Web Site: http://www.michigan.gov/lara/0,4601,7-154-11407_15368---,00.html

United States Occupational Safety and Health Standards (OSHA) (filed many different dates) which is Title 29 Part 1910 of the Code Federal Regulations. Contact UM Department of Occupational Safety and Environmental Health for projects involving toxic and/or hazardous materials.

Enforcing Agency —

United States Department of Labor.

State of Michigan Elevator Code (Effective July 11, 2014)

(Incorporating by reference the ASME A17.1 2010 Safety Code for Elevators and Escalators, the ASME A17.2 2012 Guide for Inspection of Elevators, Escalators, and Moving walks, the ASME A17.6-2010 Standard for Elevator Suspension, Compensation and Governor Systems, the ASME A17.7-2007- Performance-Based Safety Code for Elevators and Escalators, the ASME A18.1-2011 Safety Code Standard for Platform Lifts, and Stairway Chairlifts, and the ASME A90.1-2009 Safety Standard for Belt Manlifts.)

Enforcing Agency —

State of Michigan Department of Licensing and Regulatory Affairs
Bureau of Construction Codes
Elevator Safety Division
Calvin W. Rogler, Chief Elevator Inspector
PO Box 30254
Lansing, MI. 48909
(517) 241-9337

Refer to Design Guidelines for additional requirements on Elevators.

Web site for State of Michigan Elevator codes:

http://www.michigan.gov/lara/0,4601,7-154-35299_10575_17394_17420---,00.html

State of Michigan Mechanical Code 2012 Part 9a Mechanical Code Rules (Adopted Jan 17, 2014) (incorporating International Mechanical Code 2012 and Michigan amendments) promulgated by State of Michigan Department of Licensing and Regulatory Affairs, Bureau of Construction Codes.

Enforcing Agency —



University of Michigan Architecture, Engineering and Construction.

Web site for Part 9a:

http://www.michigan.gov/documents/dleg/dleg_bcc_2009_008lg_mechanical_code_rules_311916_7.pdf

State of Michigan Plumbing Code 2012 Part 7 Plumbing Code Rules (Adopted Jan 17, 2014) (Incorporating International Plumbing Code 2012 and Michigan amendments) promulgated by State of Michigan Department of Licensing and Regulatory Affairs, Bureau of Construction Codes.

By local rule the following modifications are applied to the Michigan Plumbing Code article 607.1:

607.1 (2) (h): A 1070 mixing valve is permitted to control up to 5 accessible plumbing fixtures within the same room, The 1070 mixing valve shall be certified for a minimum flow rate of 1/2 GPM or less.

Enforcing Agency —

University of Michigan Architecture, Engineering and Construction.

Web site for Part 7:

http://www.michigan.gov/documents/lara/lara_bcc_plumbing_code_rules_011714_440029_7.pdf

NFPA 13 –Sprinkler Systems. 2007. The 1996 edition of NFPA 13 is incorporated by reference in the edition of NFPA 101 incorporated by the current State of Michigan Bureau of Fire Services rules for Schools, Colleges, Hospitals, and Universities. The Bureau of Construction Codes and Fire Safety permits use of more current versions of NFPA 13 with some limitations. Contact the Bureau of Fire Services for specifics.

Enforcing Agency —

Project jurisdiction NFPA 101:

State of Michigan Department of Licensing and Regulatory Affairs

Bureau of Fire Services, Plan Review/Fire Safety

300 N. Washington Square

Lansing, MI. 48913

(517) 241-8847

Project jurisdiction MBC: University of Michigan Architecture, Engineering and Construction

NFPA 99C – Gas and Vacuum Systems (2005 edition):99C Gas and Vacuum Systems contains the rules related to gas and vacuum piping systems from the NFPA 99

Enforcing Agency —

University of Michigan Architecture, Engineering and Construction.

State of Michigan Electrical Code 2012 Part 8 Electrical Code Rules (Adopted January 17, 2014) (Incorporating NFPA 70 – National Electrical Code (2011 Edition) and Michigan



Amendments) promulgated by State of Michigan Department of Licensing and Regulatory Affairs, Bureau of Construction Codes.

By local rule the following exceptions/modifications are applied to the Michigan Electrical Code:

Michigan Electrical Code Article 80: Article 80 of the Michigan Electrical Code does not apply.

NEC 2011 Section 220.12: When the lighting system is being designed in accordance with the watts/sf and lighting controls requirements of the U-M Energy Code, the exception being added to Section 200.12 of the 2014 NEC may be applied to the 2011 NEC. Applying the exception will result in a more accurate calculation of the lighting power system load and a more appropriate sizing of the lighting power system.

NEC 2011 Section 310.15(B)(3)(c) and referenced Table 310.15(B)(3)(c): The requirement for adjusting the ampacities of conductors and cables in circular raceways exposed to sunlight on rooftops shall not be applied.

NEC 2011 Section 695.3: The requirements for power sources for electrically driven fire pumps and the requirements for 'reliable power' will be determined by the University's High Voltage Engineer, on a case-by-case basis.

NEC 2011 Sections 700.27 and 701.27: The University may deviate from full selectivity (overcurrent protective device coordination within the emergency generator distribution system) in order to lower arc-flash energy levels for worker safety. All such deviations from full selectivity will be designed by, and reviewed by, registered professional engineers.

Enforcing Agency —

University of Michigan Architecture, Engineering and Construction.

Web site for Part 8:

http://www.michigan.gov/documents/lara/lara_bcc_rules_2011_electrical_rules_070113_422907_7.pdf

NFPA 72 – National Fire Alarm Code with Appendix E (2007 edition)

The 1996 edition of NFPA 72 is incorporated by reference in the edition of NFPA 101 incorporated by the current State of Michigan Bureau of Fire Services Administrative Rules for New and Existing School, College, and University Fire Safety and Dormitory Fire Safety. The Bureau of Fire Services allows the use of new versions of NFPA 72 with some limitations. Contact the Bureau of Fire Services for specifics

Enforcing Agency —

Project jurisdiction NFPA 101:

State of Michigan Department of Licensing and Regulatory Affairs

Bureau of Fire Services, Plan Review/Fire Safety

300 N. Washington Square

Lansing, MI. 48913

(517) 241-8847



By local rule, smoke detectors that initiate an elevator recall are not to be connected to the fire alarm system. By local rule, smoke and heat detectors are not required above suspended ceilings.

Enforcing Agency —

Project jurisdiction MBC: University of Michigan Architecture, Engineering and Construction

Guide for the Care and Use of Laboratory Animals 8th Edition 2011 effective January 1 2012, promulgated by United States Department of Health and Human Services. Regulations of the Federal Animal Welfare Act 9, CFR Parts 1, 2 and 3.

Enforcing Agency —

University of Michigan Unit for Laboratory Animal Medicine.

Web site for the Guide for the Care and Use of Laboratory Animals 8th edition 2011:

<http://grants.nih.gov/grants/olaw/Guide-for-the-Care-and-Use-of-Laboratory-Animals.pdf>

Web site for Federal Animal Welfare Act 9 CFR:

Parts 1 and 2: <http://awic.nal.usda.gov/final-rules-animal-welfare-9-cfr-parts-1-and-2>

Part 3: <http://awic.nal.usda.gov/final-rules-animal-welfare-9-cfr-part-3>

Refer to “Animal Facilities Design Criteria and Special Requirements” contained in The University of Michigan Design Guidelines.

State of Michigan Rules for Soil Erosion & Sedimentation Control Promulgated by the State of Michigan Department of Environmental Quality (MDEQ) Soil Erosion and Sedimentation Control Part 91 of Public Acts 451 of 1994 as amended. The University of Michigan Occupational Safety and Environmental Health (OESH) department is approved by the MDEQ as an ‘Authorized Public Agency’ to enforce the soil erosion and sedimentation control on University of Michigan property. Refer to University of Michigan Design Guidelines Section 31 - Soil Erosion and Sedimentation Control for additional requirements.

Enforcing Agency —

University of Michigan OESH
Environmental Protection and Permitting Program (EP3)
1239 Kipke
Ann Arbor, MI. 48109-1010
(734) 936-1920

Corresponding web site—

Soil Erosion and Sedimentation Control: <http://www.oseh.umich.edu/environment/soil.shtml>

State of Michigan Issued NPDES Permit

In compliance with the provisions of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq; the "Federal Act"), Michigan Act 451, Public Acts of 1994, as amended (the "Michigan Act"), Parts 31 and 41, and Michigan Executive Orders 1991-31, 1995-4 and 1995-18, The University of Michigan (U-M) is authorized to discharge stormwater from the municipal separate storm sewer system (MS4) operated by the U-M in various locations in Michigan, and is designated as an MS4 in



accordance with the conditions set forth in U-M's National Pollutant Discharge Elimination System (NPDES) permit with the State of Michigan, Department of Environmental Quality (MDEQ).

Per the NPDES permit, projects that disturb greater than one acre of land must meet certain post-construction stormwater management requirements. Contact OSEH EP3 as soon as possible, at the beginning of a project, to discuss this requirement.

Please note that the City of Ann Arbor may also require post-construction stormwater management, above what is required by the U-M's NPDES permit, including areas disturbing less than 1 acre. This will be between the City and the Project, with input and coordination from OSEH and the U-M Planner.

Coordinating Agency—

University of Michigan OSEH
Environmental Protection and Permitting Program (EP3)
1239 Kipke Dr.
Ann Arbor, MI. 48109-1010
(734) 936-1920

Corresponding Guideline —

Stormwater Management – Post-Construction Requirements:
<http://www.oseh.umich.edu/pdf/guideline/guidePCSW.pdf>

Enforcing Agency—

Michigan Department of Environmental Quality
Jackson State Office Building
301 E. Louis Glick Highway
4th Floor, Jackson, MI 49201
517-780-7929

MDEQ Web Site: http://www.michigan.gov/deq/0,4561,7-135-3313_3682_3716---,00.html

State of Michigan Contaminated Soil and Groundwater

In compliance with Michigan Public Act 451, Part 201 (Environmental Remediation) owners/operators of properties where soil or groundwater is present above Part 201 Generic Residential Criteria have due care requirements. Due Care requirements include undertaking measures, as necessary, to prevent exacerbation of existing contamination, undertaking response activities to mitigate unacceptable exposures to contamination, taking reasonable precautions against the reasonably foreseeable acts or omissions of a third party, complying with any land use or resource use restrictions, and not impeding with the effectiveness or integrity of such restrictions.

Contact OSEH EP3 as soon as possible, at the beginning of a project, to discuss any known contamination, recommended assessments, scheduling, compliance requirements, and budget development to evaluate possible contamination or manage known contamination.

Coordinating Agency—



University of Michigan OSEH
Environmental Protection and Permitting Program (EP3)
1239 Kipke Dr.
Ann Arbor, MI. 48109-1010
(734) 936-1920

Enforcing Agency—
Michigan Department of Environmental Quality
Remediation Division
P.O. Box 30426
Lansing, MI 48909-7926
517-335-6843

MDEQ Web Site: http://www.michigan.gov/deq/0,4561,7-135-3311_4109---,00.html

State of Michigan Leaking Underground Storage Tanks

In compliance with Michigan Public Act 451, Part 213 (Leaking Underground Storage Tanks) owners/operators of underground storage tanks have requirements during the removal of underground storage tank systems to evaluate if a release to the environment has occurred. Tank removal contractors are typically obtained and managed by U-M OSEH.

Contact OSEH EP3 as soon as possible at the beginning of a project to discuss any tank removals, recommended assessments, scheduling, compliance requirements, and budget development.

Coordinating Agency—
University of Michigan OSEH
Environmental Protection and Permitting Program (EP3)
1239 Kipke Dr.
Ann Arbor, MI. 48109-1010
(734) 936-1920

Enforcing Agency—
Michigan Department of Environmental Quality
Remediation and Redevelopment Division
P.O. Box 30426
Lansing, MI 48909-7926
517-335-1104

MDEQ Web Site: http://www.michigan.gov/deq/0,1607,7-135-3311_4109_4215---,00.html

State of Michigan Underground Storage Tanks (UST)

(Permitting only, commissioning by AEC) In compliance with Michigan Public Act 451, Part 211 (Underground Storage Tank Rules), Michigan Underground Storage Tank Rules, and/or Storage and Handling of Flammable and Combustible Liquids Rules the owners/operators of underground ground storage tanks have requirements for the design, construction, installation, maintenance, and removal of tank systems.

Contact OSEH EP3 as soon as possible at the beginning of a project to discuss tank plans, scheduling, compliance requirements, and budget development.

**Coordinating Agency—**

University of Michigan OSEH
Environmental Protection and Permitting Program (EP3)
1239 Kipke Dr.
Ann Arbor, MI. 48109-1010
(734) 936-1920

Enforcing Agency—

Michigan Department of Licensing and Regulatory Affairs
Bureau of Fire Services
Storage Tank Division
P.O. Box 30426
Lansing, MI 48909-7926
517-373-9837

MDEQ Web Site: http://www.michigan.gov/lara/0,4601,7-154-35299_42271_4115_4238---,00.html

State of Michigan Aboveground Storage Tanks (AST)

(Permitting only, commissioning by AEC) In compliance with Michigan Public Act 207, Parts 2 through 5 of the rules the Aboveground Storage Tank (AST) Program regulates the following:

- storage and handling of flammable and combustible liquids with flash point less than 200 degrees Fahrenheit.
- storage and handling of liquefied petroleum gases
- compressed natural gas vehicular systems

The regulatory authority is from the Fire Prevention Code, 1941 PA 207, as amended .
Contact OSEH EP3 as soon as possible at the beginning of a project to discuss tank plans, scheduling, compliance requirements, and budget development.

Coordinating Agency—

University of Michigan OSEH
Environmental Protection and Permitting Program (EP3)
1239 Kipke Dr.
Ann Arbor, MI. 48109-1010
(734) 936-1920

Enforcing Agency—

Michigan Department of Licensing and Regulatory Affairs
Bureau of Fire Services
Storage Tank Division
P.O. Box 300700
Lansing, MI 48909
517-373-7211

Michigan AST Web Site http://www.michigan.gov/lara/0,4601,7-154-35299_42271_4115_4237---,00.html

Emergency Generators



(Permitting only, commissioning by AEC) Pending on size, fuel usage, status, reciprocating internal combustion engines are regulated per the Environmental Protection Agency and MDEQ. There are design requirements, potential permit requirements, maintenance/ recordkeeping requirements and initial notification that need to be met and submitted within 120 days of startup.

Contact OSEH EP3 as soon as possible at the beginning of a project to discuss plans, scheduling, compliance requirements, and budget development.

Coordinating Agency—

University of Michigan OSEH
Environmental Protection and Permitting Program (EP3)
1239 Kipke Dr.
Ann Arbor, MI. 48109-1010
(734) 936-1920

Enforcing Agencies—

Michigan Department of Environmental Quality
Air Quality Division
Lansing, MI 48909-7926
Environmental Protection Agency
Air and Radiation Division
Chicago, IL

MDEQ Website (RICE): http://www.michigan.gov/deq/0,4561,7-135-3310_4148-254013--,00.html

Boilers

(Air permitting only, commissioning by AEC) Pending on size, fuel usage, status, boilers are regulated per the Environmental Protection Agency and MDEQ. There are design requirements, potential permit requirements, maintenance/ recordkeeping requirements and initial notifications that need to be met and submitted within 15 days of startup.

Contact OSEH EP3 as soon as possible at the beginning of the project to discuss plans, schedules, and compliance requirements.

Coordinating Agency—

University of Michigan OSEH
Environmental Protection and Permitting Program (EP3)
1239 Kipke Dr.
Ann Arbor, MI. 48109-1010
(734) 936-1920

Enforcing Agencies—

Michigan Department of Environmental Quality
Air Quality Division
Lansing, MI 48909-7926

MDEQ Website: <http://www.michigan.gov/deq/0,4561,7-135-3304-159354--,00.html>

Environmental Protection Agency



Air and Radiation Division
Chicago, IL

EPA Boiler MACT Website: <http://www.epa.gov/airquality/combustion/actions.html>

Chemical Storage

Per the MI Part 5 Rules, Spillage of Oil and Polluting Materials, 1994 PA 451, R 324.2001 to R 324.2009, requires secondary containment and Pollution Incident Prevention Plan if bulk salt, chemical, or oil storage exceeds the threshold management quantity.

Contact OSEH EP3 as soon as possible at the beginning of a project to discuss plans, scheduling, compliance requirements, and budget development.

Coordinating Agency—

University of Michigan OSEH
Environmental Protection and Permitting Program (EP3)
1239 Kipke Dr.
Ann Arbor, MI. 48109-1010
(734) 936-1920

Enforcing Agencies—

Michigan Department of Environmental Quality
Water Division
Lansing, MI 48909-7926

MDEQ Website: http://www.michigan.gov/deq/0,4561,7-135-3313_23420---,00.html

Building Standards for University of Michigan construction that are required for subsequent licensing of the facility

**State of Michigan Department of Licensing and Regulatory Affairs, Division of Health Facilities and Services**

The Health Facilities Engineering Section (HFES) 2007 Minimum Design Standards for Health Care Facilities in Michigan and all referenced codes and standards as listed within these rules, including but not limited to NFPA 99, NFPA 101, and other NFPA and ASHRAE standards. This document is posted at

www.michigan.gov/documents/mdch/bhs_2007_Minimum_Design_Standards_Final_PDF_Doc_198958_7.pdf

All areas used by inpatients, and all areas within state jurisdiction, are to be designed to comply with HFES regulations. In general, all areas used by outpatients that fall outside HFES jurisdiction are to be designed to comply with HFES regulations. Any areas of noncompliance should be reviewed and approved by the UMHHC Design Manager.

HFES is the AHJ over all Inpatient Health Care Occupancies (defined as “Health Care Facilities” by NFPA and “I-2” by MBC. Further they are the AHJ over some “Ambulatory Health Care” Occupancies, including Outpatient Surgery and Outpatient Dialysis. The occupancy classification of “Ambulatory Health Care” needs to be carefully reviewed with the UMHHC Design Manager. Not all AHC occupancies are subject state and federal regulatory authorities.

For assistance in determining which projects are subject to HFES plan review and inspection, UMHHC has developed a flowchart available on the UMHHC FPD website at [HFES Flowchart](#). This flowchart has been reviewed by HFES, however it is not intended to replace professional judgment. Jurisdiction should be verified with HFES directly when it is not clear. Affirm decisions with the UMHHC Design Manager.

Enforcing Agency—

Michigan Department of Licensing and Regulatory Affairs
Health Facilities Division, Health Facilities Engineering Section
Ottawa Building – 1st Floor
611 W. Ottawa Street
Lansing, MI 48933
Office #: 517-241-3408

HFES Website: <http://www.michigan.gov/hfes>

Center for Medicare and Medicaid Services (CMS)

As defined at <http://www.cms.gov/>. Compliance with NFPA 101, Life Safety Code, currently enforced version (2000 as of August 2014) is required.

CMS is a federal agency that administers Medicare, works with states on Medicaid. It surveys and certifies Health Care facilities and labs for reimbursement, including Outpatient Surgery and Outpatient Dialysis. CMS also issues Survey and Certification memos and clarifications, including “Categorical Waivers” that the facility may choose to adopt. CMS requires facilities built before 2003 to comply with “Existing Health Care” and “Existing Ambulatory Health Care” chapters of NFPA 101. Facilities built after 2003 and all renovations are to comply with “New Health Care” and “New Ambulatory Health Care.”

**The Joint Commission Requirements for Accreditation of Health Care Facilities**

As defined at <http://www.jointcommission.org/>. The Joint Commission (TJC) is the largest and most recognized accreditation organization that the state and CMS recognize for licensure and reimbursement. TJC surveys to the codes adopted by CMS.

State of Michigan Department of Licensing and Regulatory Affairs, Bureau of Health Systems, Radiation Safety Section

All projects which include radiation-producing equipment used for diagnostic and therapy procedures. All radiation-producing equipment must be registered with the Michigan Department of Licensing and Regulatory Affairs through OSEH/Radiation Safety Service prior to initial use.

Enforcing Agency—

Radiation Safety Section

Michigan Department of Licensing and Regulatory Affairs

Michigan Occupational Safety and Health Administration (MIOSHA)

P.O. Box 30643

Lansing, Michigan 48909-8143

Phone: 517-636-6800

Website: http://www.michigan.gov/lara/0,4601,7-154-61256_11407_35791-46433--,00.html

State of Michigan Department of Licensing and Regulatory Affairs, Bureau of Fire Services (BFS) promulgated by the State of Michigan Bureau of Fire Services (incorporating by reference NFPA 101 – Life Safety Code 2006) and all other codes and standards currently enforced.

For assistance in determining which projects are subject to plan review and inspection, and BFS fire alarm and fire suppression shop drawing review and inspection, UMHHC FPD has developed a flowchart available at [BFS Flowchart](#). This flowchart has been reviewed by BFS, however it is not intended to replace professional judgment. Jurisdiction should be verified with BFS directly when it is not clear. Affirm decisions with UMHHC Design Manager.

Enforcing Agency —

State of Michigan Department of Licensing and Regulatory Affairs

Bureau of Fire Services, Fire Safety Plan Review Division

525 W Allegan 4th Floor

Lansing, MI. 48913-0001

(517) 241-8847

Administrative rules web site: http://www7.dleg.state.mi.us/orr/Files/AdminCode/965_2011-003LR_AdminCode.pdf

Application forms under Bureau Fire Services:

http://www.michigan.gov/documents/dleg_bccfs_plrvwinsp_87149_7.pdf**ASHRAE / ASHE Standard 170-2013 “Ventilation of Health Care Facilities”**



Compliance with ASHRAE/ASHE Standard 170-2013 is required for all facilities which contain patient areas, including non-patient areas within the same building.

Website: <https://www.ashrae.org/news/2013/ashrae-publishes-revised-standard-on-ventilation-in-health-care-facilities->

University of Michigan Leased Health Care Facilities

UMHHC leases many facilities which are subject to local municipal jurisdiction, in addition to UMHHC Design Guidelines and Preferred Manufacturer's List (PML). For more information on ownership status and physical addresses for all buildings, please consult with the UMHHC Design Manager.

Toxic and/or Hazardous Materials at University of Michigan Health Care Facilities

Contact UMHHC Safety Management Services for projects involving toxic and / or hazardous materials.

Coordinating Agency —

Michigan House
2301 Commonwealth Blvd Floor 2
SPC 2945
Ann Arbor, MI 48105
(734) 764-4427
Email: safetymgmt-safety@med.umich.edu

Website: <http://www.med.umich.edu/sms/>

Aviation, Pharmacy, Psychology, and Pathology, etc.

Consult corresponding clinical department for information on additional regulatory agencies including but not limited to the list above.

State of Michigan Rules for Construction or Renovation of Food Service Facilities

Promulgated by the State of Michigan Department of Agriculture and Rural Development (Food and Dairy Division). Act 92, [Food Law](#) which incorporates by reference chapters 1 through 8 of the [2009 Michigan Modified Food and Drug Administration Food Code](#). Visit the University of Michigan Department of Occupational Safety and Environmental Health website <http://www.oseh.umich.edu/food/planreview.shtml> for instruction sheet information and a copy of the Plan Review Packet and Worksheet that must be completed prior to starting a project. The University of Michigan Occupational Safety and Environmental Health (OEH) Department is the enforcing agency with authorization provided by the Washtenaw County Environmental Health Department.

Enforcing Agency—



University of Michigan OSEH
Operational Health and Safety
1239 Kipke
Ann Arbor, MI. 48109-1010
(734) 647-1142

State of Michigan Rules for Construction or Renovation of Swimming Pools

Promulgated by the State of Michigan Department of Environmental Quality (Water Division). Michigan's Public Health Code, [Public Act 368 of 1978, Part 125](#). Contact University of Michigan Department of Occupational Safety and Environmental Health for information. The University of Michigan Occupational Safety and Environmental Health (OSEH) Department is the enforcing agency with authorization provided by the Washtenaw County Environmental Health Department.

Enforcing Agency—
University of Michigan OSEH
Operational Health and Safety
1239 Kipke
Ann Arbor, MI. 48109-1010
(734) 647-1142

Also see 15010 “Basic Mechanical Requirements” for additional codes and standards applicable to mechanical work on University projects.

State of Michigan Department of Environmental Quality (MDEQ) (filed many different dates) Contact U of M Department of Occupational Safety and Environmental Health for information on environmental regulatory requirements. All project specific communication with the enforcing agency must be through or coordinated with the U of M Occupational Safety and Environmental Health Department.

Coordinating Agency—
University of Michigan OSEH
Environmental Protection and Permitting Program (EP3)
1239 Kipke
Ann Arbor, MI 48109-1010
(734) 936-1920

OSEH Web Site: <http://www.oseh.umich.edu/>

- Environmental Protection: <http://www.oseh.umich.edu/environment/index.shtml>
- Air permitting (generators, boilers, refrigeration units):
<http://www.oseh.umich.edu/environment/air.shtml>
- Power washing and discharge to ground:
<http://www.oseh.umich.edu/environment/groundwater.shtml>
- Remediation: <http://www.oseh.umich.edu/environment/remediation.shtml>
- Storage Tanks: <http://www.oseh.umich.edu/environment/tanks.shtml>



- Threatened and Endangered Species:
<http://www.oseh.umich.edu/environment/endangered.shtml>
- Wetlands: <http://www.oseh.umich.edu/environment/wetland.shtml>

Enforcing Agency—

Michigan Department of Environmental Quality 525 West Allegan Street P.O. Box 30473
Lansing, MI 48909-7973 (800) 662-9278

MDEQ Web Site: <http://www.michigan.gov/deq>

United States Environmental Protection Agency (USEPA) (filed many different dates), which is Title 40 of the Code Federal Regulations. Contact U-M Department of Occupational Safety and Environmental Health for information on environmental regulatory requirements. All project specific communication with the enforcing agency must be through or coordinated with the U of M Occupational Safety and Environmental Health department.

Coordinating Agency—

University of Michigan OSEH
Environmental Protection and Permitting (EP)
1239 Kipke
Ann Arbor, MI 48109-1010
(734) 936-1920

OSEH Web Site: <http://www.oseh.umich.edu/>

Enforcing Agency—

United States Environmental Protection Agency
Region 5 (IL, IN, MI, MN, OH, WI) 77 West Jackson Boulevard Chicago, IL 60604-3507
(312) 353-2000

USEPA Web Site: <http://www.epa.gov/>

**University of Michigan Buildings
That Contain Instructional Space**

(Based on M-Pathways GQL database for rooms with type code 110 or 210)

BLDG BLDG**NO NAME**

5179 202 SOUTH THAYER
0879 555 SOUTH FOREST BUILDING
5037 A. A. TAUBMAN BIOMEDICAL SCIENCE RESEARCH BUILDING (Auditorium)*
0421 AERO ENG - WIND TUNNEL LAB (FA/FS only)
0425 AERO ENG - PLASMA RESEARCH (FA/FS only)
0422 AERO ENG - PROPULSION LAB (FA/FS only)
0423 AERO ENG - PUMPING STATION (FA/FS only)
0168 ANIMAL RESEARCH FACILITY
0206 ANGELL HALL ADDITION-AUDITORIUMS
0175 ANGELL HALL ADDITION-HAVEN HALL
0197 ANGELL HALL ADDITION-MASON HALL
0152 ANGELL JAMES B HALL & TISCH HALL
0831 ARGUS II
0432 ART & ARCHITECTURE BUILDING
0395 BAGNOUD, FRANCOIS-XAVIER BUILDING
5092 BESTER, BOB & BETTY BUILDING
4016 BIOLOGICAL ST BLANCHARD
4010 BIOLOGICAL ST CORT LABORATORY
4018 BIOLOGICAL ST CREASER LABORATORY
4005 BIOLOGICAL ST FOREST LABORATORY
4011 BIOLOGICAL ST HOUGHTON LAB
4013 BIOLOGICAL ST HUNGERFORD LAB
4037 BIOLOGICAL ST LECTURE HALL
4019 BIOLOGICAL ST NEWCOMBE LAB
4015 BIOLOGICAL ST PETTINGILL LAB
4017 BIOLOGICAL ST REIGHARD LAB
4039 BIOLOGICAL ST SPARROW LABORATORY
4096 BIOLOGICAL ST STOCKARD LABORATORY
4012 BIOLOGICAL ST WELCH LABORATORY
0407 BROWN, G G LABORATORY
0210 BUHL RES CEN FOR HUMAN GENETICS
0155 BURTON MEMORIAL TOWER
0226 CENTRAL CAMPUS REC BLD&BELL POOL
0158 CHEMISTRY & DOW W H LAB
0443 CHRYSLER CNTR CONT ENGINEER ED
0138 COMPUTER&EXECUTIVE EDUCATION BLD
0403 COOLEY, MORTIMER E MEMORIAL
0189 DANA, SAMUEL TRASK BUILDING
0225 DANCE BUILDING
1012 DB ADMIN & STUDENT ACTIVITIES BLDG
1020 DEARBORN CASL ANNEX & FAIRLANE APT
1080 DEARBORN COL ARTS SCIENCE & LETTERS
8049 DEARBORN COMMERCE PARK
1011 DEARBORN COMPUTER & INFOR SCIENCE
1013 DEARBORN ENGINEERING LAB BLDG
1076 DB ENVIRONMENTAL INTERPRET CTR
5128 DB FAIRLANE CENTER - NORTH (FA & FS only)
5128 DEARBORN FAIRLANE CENTER - SOUTH
1017 DB FIELD HOUSE AND WELLNESS CENTER
1065 DEARBORN MARDIGIAN LIBRARY
1078 DB PROFESSIONAL EDUCATION CENTER
1079 DEARBORN SCI BLDG-COMPUTING WING
1009 DB SCIENCE, CLASSROOM & ADMIN.
1077 DEARBORN SOCIAL SCIENCES BUILDING
1060 DEARBORN UNIVERSITY CENTER
0165 DENNISON, DAVID M BUILDING
0162 DENTAL AND W K KELLOGG INSTITUTE
0447 DOW, HERBERT H BUILDING
0166 EAST HALL
0054 EAST QUADRANGLE

BLDG BLDG**NO NAME**

0221 EDUCATION, SCHOOL OF
0448 ELECTRICAL ENG & COMPUTER SCI BLDG
0435 ENGINEERING RES BLDG I (FA only)*
0436 ENGINEERING RESEARCH BUILDING II
0414 ENVIRONMENTAL & WATER RES ENG BL
1650 FLINT DAVID FRENCH HALL
1670 FLINT HARDING MOTT UNIV CENTER
1607 FLINT LAPEER ST ANNEX
1671 FLINT RECREATION BUILDING
1630 FLINT WM R MURCHIE SCIENCE BLDG
5219 FLINT STUDENT HOUSING FACILITY
1662 FLINT UNIVERSITY PAVILION
1664 FLINT UNIV PAVILION ANNEX
1694 FLINT WILLIAM S WHITE BUILDING
0234 FRANCIS, THOMAS JR PUBLIC HEALTH
0437 GERSTACKER, CARL A BLDG (FA only)*
0424 GORGUZE FAMILY LABORATORY
0179 HUTCHINS HALL (All areas except Aikens Commons & Café Room 150)*
0429 INDUSTRIAL & OPERATIONS ENGIN BLDG
0324 KELLOGG, W K EYE CENTER
0851 KINESIOLOGY BUILDING (Stair S01, Rooms 1100, 2100, & 3100)*
0211 KRAUS, EDWARD HENRY BUILDING
0137 KRESGE BUSINESS ADMIN LIBRARY
0101 KRESGE HEARING RESEARCH
0400 LAY, WALTER E AUTOMOTIVE LAB
0150 LITERATURE SCIENCE AND THE ARTS (3rd Flr)*
0188 LITTLE, CLARENCE COOK SCIENCE BLD
0059 LLOYD, ALICE C HALL
0154 LORCH HALL
8049 LP BUSINESS ADMIN 15041 COMMERCE
0406 LURIE, ANN AND ROBERT H BIOMEDICAL ENG
0982 MATTHAEI BOT GDNS RESEARCH-ADMIN
0190 MEDICAL SCIENCE UNIT I
0200 MEDICAL SCIENCE UNIT II
0207 MODERN LANGUAGES BUILDING
0440 MOORE, EARL V BLDG
0061 MOSHER-JORDAN HALL
0151 MUSEUM OF ART (Auditorium & Stair S5)*
0415 NAVAL ARCH & MARINE ENGINEERING
0196 NORTH HALL
5177 NORTH QUAD COMPLEX (Level 1 throughout & Level 2 North Tower) *
5047 PALMER DRIVE COMMONS (SW end of 2nd floor)*
0890 PERRY BUILDING (G300)*
0442 PIERPONT COMMONS (Basement level)*
0180 POWER CENTER FOR PERFORMING ARTS
0897 PUBLIC POLICY ANNEX
0208 RANDALL, HARRISON M LABORATORY
0416 RADIATION SCIENCES LAB 1 (FA/FS only)
0417 RADIATION SCIENCES LAB 2 (FA/FS only)
5188 ROSS SCHOOL OF BUSINESS (Floors B, 1, 2, & 3)*
5120 ROSS, STEPHEN M ACADEMIC CENTER
0193 RUTHVEN, ALEXANDER G MUSEUMS BLDG
0333 SCHOOL OF NURSING BUILDING
0219 SCHOOL OF SOCIAL WORK BUILDING
5235 SOUTH HALL
0441 SPACE RESEARCH LABORATORY
5224 STAMPS AUDITORIUM
0445 STEARNS, FREDERICK BUILDING

**BLDG BLDG****NO NAME**

0216 TAPPAN HALL
0209 TAUBMAN, A A. HEALTH SCIENCES LIBRARY
5046 UNDERGRADUATE SCIENCE BLDG
0204 VAUGHAN, H F PUBLIC HLTH BL(1st & 2nd Flrs)*

BLDG BLDG**NO NAME**

5059 WALGREEN, CHARLES RJ DRAMA CENTER
5101 WEILL HALL, JOAN & SANFORD (1st & 2nd Flrs)*
0167 WEST HALL
0135 WYLY, SAM HALL

(*) Indicates compartment of jurisdiction. Note egress from compartment; fire alarm & fire suppression for entire bldg are under BFS.

**University of Michigan Buildings
That Contain Dormitory Space**

(Based M-Pathways GQL database for rooms with type code 910, 919, 920, and 935)

BLDG BLDG**NO NAME**

0510 BAITS, VERA I EATON HOUSE
0511 BAITS, VERA I LEE HOUSE
0512 BAITS, VERA I PARKER HOUSE
0513 BAITS, VERA I SMITH HOUSE
0514 BAITS, VERA I STANLEY HOUSE
0515 BAITS, VERA II COMAN HOUSE
0516 BAITS, VERA II CONGER HOUSE
0517 BAITS, VERA II CROSS HOUSE
0518 BAITS, VERA II THIEME HOUSE
0519 BAITS, VERA II ZIWET HOUSE
0051 BARBOUR, BETSY HOUSE
0555 BURSLEY HALL
0120 CAMBRIDGE HOUSE (Compartment w/in MICHIGAN UNION)*
0109 COOK, JOHN P LAW QUADRANGLE
0052 COOK, MARTHA RESIDENCE
0053 COUZENS HALL
0054 EAST QUADRANGLE
0055 FLETCHER HALL

BLDG BLDG**NO NAME**

0057 HENDERSON, MARY B HOUSE
0108 LAWYERS CLUB
0059 LLOYD ALICE C HALL
0060 MARKLEY, MARY B HALL
0061 MOSHER-JORDAN HALL
0062 NEWBERRY RESIDENCE
5177 NORTH QUAD COMPLEX (North Tower levels 3 through 10)*
0040 OH GODDARD HALL
0042 OH ADELIA CHEEVER RESIDENCE
0043 OH GEDDES RESIDENCE
0044 OH JULIA E EMANUEL RESIDENCE
0046 OH L H SEELEY HALL
0045 OH PAMELA NOBLE RESIDENCE
0041 OH VANDENBERG HALL
0063 SOUTH QUADRANGLE
0064 STOCKWELL HALL
0066 WEST QUADRANGLE

**University of Michigan Buildings
That Contain Child Care Space**

(Based M-Pathways GQL database for rooms with type code 640, and 645)

BLDG BLDG**NO NAME**

5244 DEARBORN CHILD DEVELOPMENT CENTER
1047 DEARBORN KINDERGARDEN MODULE
5018 NCRC (N Campus Research Complex) B075 CHILDREN'S CENTER
0600 NORTHWOOD COMMUNITY CENTER
0333 SCHOOL OF NURSING BUILDING
5240 TOWSLEY CHILDREN'S HOUSE
0390 UNIVERSITY HOSPITALS CHILD CARE CENTER

**University of Michigan Buildings
That Are Inpatient & Health Care Facilities****BLDG BLDG****NO NAME**

5102 BREHM TOWER (BRM) (Eye Center Expansion) (Fourth Floor)*
5109 SAMUEL AND JEAN FRANKEL CARDIOVASCULAR CENTER (CVC)
0313 CONNECTOR between UH and MOTT adjacent to TOWSLEY
0312 UNIVERSITY HOSPITAL SOUTH UNIT 2 (old Mott)
0314 UNIVERSITY HOSPITAL SOUTH UNIT 3 (old Holden)
0318 UNIVERSITY HOSPITAL SOUTH UNIT 4 (old MCHC)
5173 C.S. MOTT CHILDREN'S AND VON VOIGTLANDER WOMEN'S HOSPITAL
0316 UNIVERSITY HOSPITAL (UH)

For more detailed boundaries for inpatient facilities in all buildings, please consult with UMHHC Design Manager.



**University of Michigan Buildings
That Contain Ambulatory Surgery Centers**

BLDG BLDG

NO NAME

5038 EAST ANN ARBOR AMBULATORY SURGERY CENTER

8096 LIVONIA CENTER FOR SPECIALTY CENTER

**University of Michigan Buildings
That Contain Outpatient Dialysis**

BLDG BLDG

NO NAME

8072 EISENHOWER PARK WEST

8096 LIVONIA CENTER FOR SPECIALTY CENTER



- HOME
- ABOUT US
- PROJECTS
- MAPS & DETOURS
- MASTER PLANNING
- POLICIES & PROCEDURES
- SUSTAINABILITY
- SAFETY

- FOR U-M CLIENTS
- FOR VENDORS
- FOR U-M AEC STAFF

OUT TO BID

DESIGN GUIDELINES

CODES & REGULATORY AGENCIES

DESIGN DELIVERABLES

SUSTAINABILITY

SPECIAL INSTRUCTIONS TO DESIGNERS

SPECIAL BUILDING AREAS

OFFICE SPACE

TECHNICAL SECTIONS

STANDARD DETAILS

MASTER SPECIFICATIONS

PREFERRED MANUFACTURERS

HEALTH SYSTEM PROJECTS

EFFECTIVE DATE


BUILDING COMMISSIONING

CONTRACTS & AGREEMENTS

CONTRACTOR RESOURCES

OTHER LINKS

DESIGN DELIVERABLES

As part of the deliverables for formal UM review at each of the major phases of design listed below, the Design Professional shall submit this “[Design Deliverables](#)”  document to the University’s Design Coordinator. On the “Design Deliverables” document, the Design Professional shall indicate the status of each required item (a check mark is interpreted to mean that an item has been included in the deliverables). On or attached to the “Design Deliverables” document, the Design Professional shall address any item that is NOT included in the review package.

Note that design deliverables for the Design Development phase are to include all items listed in the Design Development column of the “Design Deliverables” table AND, except as specifically stated to the contrary in the

table, all items listed in the Schematic Design column of the table (which are to have been further developed during Design Development).

Note that design deliverables for the Construction Document phase are to include all items listed in the Construction Document column of the “Design Deliverables” table AND, except as specifically stated to the contrary in the table, all items listed in the Schematic Design column and all items listed in the Design Development column of the table (which are to have been further developed during the Construction Document phase).

U-M Gateway | Business & Finance | Facilities & Operations
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326 East Hoover, Ann Arbor, MI 48109-1002
Phone: (734) 763-3020
Contact Us

DESIGN DELIVERABLES
APRIL 2014

As part of the deliverables for formal UM review at each of the major phases of design listed below, the Design Professional shall submit this "Design Deliverables" document to the University's Design Coordinator. On the "Design Deliverables" document, the Design Professional shall indicate the status of each required item (a check mark is interpreted to mean that an item has been included in the deliverables). On or attached to the "Design Deliverables" document, the Design Professional shall identify all items NOT included in the review package.

Note that design deliverables for the Design Development phase are to include all items listed in the Design Development column of the "Design Deliverables" table AND, except as specifically stated to the contrary in the table, all items listed in the Schematic Design column of the table (which are to have been further developed during Design Development).

Note that design deliverables for the Construction Document phase are to include all items listed in the Construction Document column of the "Design Deliverables" table AND, except as specifically stated to the contrary in the table, all items listed in the Schematic Design column and all items listed in the Design Development column of the table (which are to have been further developed during the Construction Document phase).

ITEM	SCHEMATIC PHASE	DESIGN DEVELOPMENT PHASE	CONSTRUCTION DOCUMENT PHASE
GENERAL DESCRIPTION	<input type="checkbox"/> 1. Scope of work narrative <input type="checkbox"/> 2. Comparison of capacities (see "Building Interior" for area comparison) to program <input type="checkbox"/> 3. List of applicable building codes on drawing title sheet <input type="checkbox"/> 4. Building code review (describe means of compliance for major code issues and building systems) <input type="checkbox"/> 5. List of anticipated building code variance requests <input type="checkbox"/> 6. Anticipated building and space occupancy schedules <i>(continued)</i>	<input type="checkbox"/> 14. Description of construction phasing <input type="checkbox"/> 15. Description of any proposed occupancy within construction area <input type="checkbox"/> 16. Description of water & vapor characteristics of roof & exterior walls	<input type="checkbox"/> 17. Documentation on drawings as required by building codes (specifically to include indication of maximum allowable number of people in each room) <input type="checkbox"/> 18. List of all code variances (on drawings cover sheet) <input type="checkbox"/> 19. When special inspection or testing is required by building code, a separately bound "Statement of Special Inspections" as stipulated by building code <input type="checkbox"/> 20. If multiple bid packages, clear indication of scope of each release <i>(continued)</i>

ITEM	SCHEMATIC PHASE	DESIGN DEVELOPMENT PHASE	CONSTRUCTION DOCUMENT PHASE
<p>GENERAL DESCRIPTION <i>(continued)</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> 7. Life safety (egress) plans with identification of security and access control points <input type="checkbox"/> 8. For projects over \$5 million construction cost, UM's list of outstanding Facility Condition Assessment improvement recommendations with notation as to which will be addressed by the project. <input type="checkbox"/> 9. Owner's Project Requirements and Basis of Design documents as described in SID-B "Design Intent Documents" <input type="checkbox"/> 10. Demonstration of compliance with SID-D "Energy and Water Conservation". See SID-D for deliverables requirements <input type="checkbox"/> 11. For projects over \$10 million construction cost, Energy Impact Statement as described in SID-D "Energy and Water Conservation" <input type="checkbox"/> 12. List of sustainability features incorporated into project design as described in SID-K "Sustainable Design and LEED Requirements" <input type="checkbox"/> 13. For new non-clinical building projects over \$10 million construction cost, information as required to apply for LEED Silver (or higher) certification, and a project-specific LEED Checklist, both as described in SID-K "Sustainable Design and LEED Requirements" 		<ul style="list-style-type: none"> <input type="checkbox"/> 21. Identification of construction phasing, including temporary requirements during each phase <input type="checkbox"/> 22. When requested by the U-M Design Manager, electronic Microstation or AutoCAD files (with or without the Design Professional's title block) of CD Phase drawings for use by U-M or the Construction Manager as backgrounds for special construction bid packs (e.g. telephone/data and audio/visual wiring bid packs)

ITEM	SCHEMATIC PHASE	DESIGN DEVELOPMENT PHASE	CONSTRUCTION DOCUMENT PHASE
SPECIFICATIONS	<input type="checkbox"/> 1. System & material narrative description	<input type="checkbox"/> 2. Outline or preliminary specifications indicating project specific features of major equipment as well as component materials, e.g. “welded Schedule 40 steel pipe”, “quarter sawn oak”, etc. w/ same section numbering as final specification	<input type="checkbox"/> 3. Complete specification including draft front end documents <input type="checkbox"/> 4. List of items which are sole-sourced or dual-sourced and justification for not specifying three acceptable products <input type="checkbox"/> 5. For items listed in UM's "Preferred Manufacturers List", a table of specified items that are NOT indicated in UM's PML, and the justification for specifying these items <input type="checkbox"/> 6. For door hardware sets that require electricity, indicate the proposed sequence of operations for the hardware
SITE	<input type="checkbox"/> 1. Site plans, to include the following: a. Existing conditions b. Demolition c. Building outline(s) d. Future expansion e. Site entrance f. Roads & driveways g. Parking locations h. Bus stop/shelter (if required) i. Loading dock location j. Waste/recycling collection locations k. Walkway locations l. Stairway locations m. Emergency telephone locations n. Utility requirements o. Site utilities p. Preliminary grading plan q. Soil retention work, if needed <i>(continued)</i>	<input type="checkbox"/> 5. General dimensions & elevations <input type="checkbox"/> 6. Permanent exterior signage <input type="checkbox"/> 7. Parking/roadway plans & elevations <input type="checkbox"/> 8. Vehicle & pedestrian traffic controls (if required) <input type="checkbox"/> 9. Grading plan <input type="checkbox"/> 10. Site lighting plans, simulations, specifications, equipment cut sheets and photometrics (as defined in Design Guideline 16521) <input type="checkbox"/> 11. Concept details of site fixtures & equipment <input type="checkbox"/> 12. Utility plans, elevations & details for local governing agency approval <input type="checkbox"/> 13. Sanitary sewer flow calculations for OSEH approval <input type="checkbox"/> 14. Plan to address existing hazardous/contaminated materials, if applicable <i>(continued)</i>	<input type="checkbox"/> 18. Extent of construction area <input type="checkbox"/> 19. Area traffic plan, if existing roads/walks are impacted <input type="checkbox"/> 20. Site development phasing <input type="checkbox"/> 21. Construction site access <input type="checkbox"/> 22. Staging area <input type="checkbox"/> 23. Construction signage <input type="checkbox"/> 24. Site details, including hardscape <input type="checkbox"/> 25. Profiles for underground utilities <input type="checkbox"/> 26. Pipe sizes <input type="checkbox"/> 27. Connection details <input type="checkbox"/> 28. Copy of local government review comments on utilities and modifications in right(s)-of-way

ITEM	SCHEMATIC PHASE	DESIGN DEVELOPMENT PHASE	CONSTRUCTION DOCUMENT PHASE
<i>SITE (continued)</i>	<input type="checkbox"/> 2. Site plan for public use (see SID-H) <input type="checkbox"/> 3. Storm water management plan <input type="checkbox"/> 4. Preliminary site lighting plan	<input type="checkbox"/> 15. Soil erosion and sedimentation control plan (for both construction and occupancy) <input type="checkbox"/> 16. Soil erosion and sedimentation control "Design & Review Checklist" described in UM Design Guidelines Section 02215 <input type="checkbox"/> 17. Dewatering plan	
<i>LANDSCAPING</i>	<input type="checkbox"/> 1. Existing conditions <input type="checkbox"/> 2. Landscaping concept <input type="checkbox"/> 3. Existing irrigation	<input type="checkbox"/> 4. Planting plan <input type="checkbox"/> 5. Irrigation plan	<input type="checkbox"/> 6. Protection for existing trees and significant plantings during construction <input type="checkbox"/> 7. Soil preparation & planting specifications <input type="checkbox"/> 8. Guying diagrams <input type="checkbox"/> 9. Piping diagrams <input type="checkbox"/> 10. Pipe sizes <input type="checkbox"/> 11. Landscape and irrigation details and legends
<i>STRUCTURAL</i>	<input type="checkbox"/> 1. Structural scheme plans <input type="checkbox"/> 2. Written description	<input type="checkbox"/> 3. Foundation plan <input type="checkbox"/> 4. Typical floor framing plan <input type="checkbox"/> 5. Framing plans at unique features <input type="checkbox"/> 6. Main member sizing <input type="checkbox"/> 7. Structural sections	<input type="checkbox"/> 8. Definition of control joints <input type="checkbox"/> 9. Beam, column & slab schedules <input type="checkbox"/> 10. Mechanical and electrical concrete house keeping pads <input type="checkbox"/> 11. Foundation details <input type="checkbox"/> 12. Structural details <input type="checkbox"/> 13. Structural notes <input type="checkbox"/> 14. Structural calculations
<i>BUILDING EXTERIOR ENVELOPE</i>	<input type="checkbox"/> 1. Typical elevations <input type="checkbox"/> 2. Fenestration layout <input type="checkbox"/> 3. Material designations <input type="checkbox"/> 4. Overall building cross-sections <input type="checkbox"/> 5. Roof layout	<input type="checkbox"/> 6. All building elevations w/dimensional heights <input type="checkbox"/> 7. Typical wall sections <input type="checkbox"/> 8. Parapet & coping details <input type="checkbox"/> 9. Roof & drainage plan <input type="checkbox"/> 10. Exterior door details <input type="checkbox"/> 11. Typical window details <input type="checkbox"/> 12. Details of unique features <input type="checkbox"/> 13. Expansion joint locations <input type="checkbox"/> 14. Large scale building cross-sections	<input type="checkbox"/> 15. Roof-mounted equipment <input type="checkbox"/> 16. Roof details <input type="checkbox"/> 17. Exterior details <input type="checkbox"/> 18. Flashing details <input type="checkbox"/> 19. Control joint definition & details

ITEM	SCHEMATIC PHASE	DESIGN DEVELOPMENT PHASE	CONSTRUCTION DOCUMENT PHASE
<i>BUILDING INTERIOR</i>	<input type="checkbox"/> 1. Typical floor plans (min 1/16" scale) w/ legends <input type="checkbox"/> 2. Floor plans for room numbering & public use (see SID-H) <input type="checkbox"/> 3. Demolition plans <input type="checkbox"/> 4. All room numbers (comply with Design Guidelines Section 10400) <input type="checkbox"/> 5. Area use identification & area in square ft. <input type="checkbox"/> 6. Mechanical, electrical & other service closets & rooms <input type="checkbox"/> 7. Circulation paths <input type="checkbox"/> 8. Area tabulations compared to program requirements <input type="checkbox"/> 9. Show flexibility for expansion & alterations <input type="checkbox"/> 10. Preliminary layout of major spaces w/ fixed equipment	<input type="checkbox"/> 11. All floor plans (min 1/16" scale) <input type="checkbox"/> 12. Enlarged plans at elevation changes (such as stairs) <input type="checkbox"/> 13. Enlarged plans at toilet rooms <input type="checkbox"/> 14. Reflected ceiling plans <input type="checkbox"/> 15. Wall types, fire ratings, smoke control zones <input type="checkbox"/> 16. Plan to address existing hazardous materials, if applicable <input type="checkbox"/> 17. Fixed seating <input type="checkbox"/> 18. Defined seating, serving, & kitchen facilities <input type="checkbox"/> 19. Equipment & furniture layouts <input type="checkbox"/> 20. Important interior elevations <input type="checkbox"/> 21. Details of unique features <input type="checkbox"/> 22. Details of fixed equipment <input type="checkbox"/> 23. Preliminary finish schedule <input type="checkbox"/> 24. Preliminary door schedule <input type="checkbox"/> 25. Informational signage	<input type="checkbox"/> 26. Dimensioned floor plans <input type="checkbox"/> 27. Enlarged plans <input type="checkbox"/> 28. Partition details <input type="checkbox"/> 29. Interior details <input type="checkbox"/> 30. Interior elevations <input type="checkbox"/> 31. Finish schedules <input type="checkbox"/> 32. Door & hardware schedules <input type="checkbox"/> 33. Room signage <input type="checkbox"/> 34. Schedule of proposed movable equipment that is NOT indicated on documents (for reference) <input type="checkbox"/> 35. Schedule of lab fixtures (turrets, etc.), if applicable
<i>ELEVATORS</i>	<input type="checkbox"/> 1. Elevator locations <input type="checkbox"/> 2. Equipment room locations	<input type="checkbox"/> 3. Elevator shaft section <input type="checkbox"/> 4. Equipment description	<input type="checkbox"/> 5. Dimensioned plans <input type="checkbox"/> 6. Sections & details of hydraulic cylinder, if applicable <input type="checkbox"/> 7. Description of shaft sump pits <input type="checkbox"/> 8. Elevator car & equipment support details <input type="checkbox"/> 9. Description of controls & fixtures <input type="checkbox"/> 10. Door & frame details <input type="checkbox"/> 11. Interior details including lighting
<i>HVAC</i>	<input type="checkbox"/> 1. Identify all systems <i>(continued)</i>	<input type="checkbox"/> 9. Overall building air flow diagram indicating air handlers, exhaust fans, duct risers, and duct mains <i>(continued)</i>	<input type="checkbox"/> 21. Detailed piping and duct design with all sizes indicated <i>(continued)</i>

ITEM	SCHEMATIC PHASE	DESIGN DEVELOPMENT PHASE	CONSTRUCTION DOCUMENT PHASE
<p align="center">HVAC <i>(continued)</i></p>	<ul style="list-style-type: none"> <input type="checkbox"/> 2. One-line diagrams for each air, hydronic, steam, condensate and all other HVAC related systems, and other materials as required to describe the fundamental design concept for all mechanical systems <input type="checkbox"/> 3. Indication of the amount of redundancy for all major pieces of mechanical equipment, e.g. “two pumps 100% capacity each” <input type="checkbox"/> 4. Major equipment locations <input type="checkbox"/> 5. Air intake & discharge locations <input type="checkbox"/> 6. Gross HVAC zoning, and typical individual space zoning (e.g. VAV boxes per office =?) <input type="checkbox"/> 7. Mechanical legend <input type="checkbox"/> 8. Special occupancy zones 	<ul style="list-style-type: none"> <input type="checkbox"/> 10. Plans indicating shaft, chase, recess requirements <input type="checkbox"/> 11. Duct layout for typical spaces <input type="checkbox"/> 12. Equipment schedules (major equipment) <input type="checkbox"/> 13. Equipment locations (w/enlarged mechanical plans) <input type="checkbox"/> 14. Indication of typical locations of fire dampers, smoke dampers, and combination F/S dampers <input type="checkbox"/> 15. Control diagrams (concept form) for all mechanical and plumbing systems <input type="checkbox"/> 16. Outline of major control sequences of operation <input type="checkbox"/> 17. M/E smoke control schemes <input type="checkbox"/> 18. Preliminary floor plans of mechanical rooms w/all components and required service access areas drawn to scale <input type="checkbox"/> 19. Preliminary calculations <input type="checkbox"/> 20. Meter locations and types 	<ul style="list-style-type: none"> <input type="checkbox"/> 22. Floor plans w/ all components and required service access areas drawn to actual scale. On the plans, indicate duct sizes and air flow quantities relative to each room, including CFM in and out of all doors. Indicate location of control panels <input type="checkbox"/> 23. Lab air valves and volume control boxes (note that each is to be identified by a unique number assigned by the engineer). Provide a schedule that indicates the control sequence that applies to each room (room #, room descriptor, control sequence #) <input type="checkbox"/> 24. Detailed floor plans of mechanical rooms w/ all components and required service access areas drawn to actual scale <input type="checkbox"/> 25. Cross-sections through mechanical rooms and areas where there are installation/coordination issues (tight space, zoning of utilities). Indicate required service access areas <input type="checkbox"/> 26. In common mechanical space, indication of space zoning by system <input type="checkbox"/> 27. Connection to fire alarm & campus control systems <input type="checkbox"/> 28. Equipment details, including structural support requirements <input type="checkbox"/> 29. Penetration/sleeve details <input type="checkbox"/> 30. Installation details <input type="checkbox"/> 31. Duct construction schedule (on the drawings), indicating materials and pressure class for each duct system <i>(continued)</i>

ITEM	SCHEMATIC PHASE	DESIGN DEVELOPMENT PHASE	CONSTRUCTION DOCUMENT PHASE
HVAC <i>(continued)</i>			<input type="checkbox"/> 32. Detailed controls drawings, including clear differentiation of trade responsibility for control, fire, and control power wiring <input type="checkbox"/> 33. Detailed sequences of operation including the specific setpoints for all control loops that will result in attainment of the required design criteria, as well as alarm setpoints and time delays <input type="checkbox"/> 34. Design calculations
PLUMBING & PIPING	<input type="checkbox"/> 1. One-line (riser) diagrams for every plumbing system (e.g. domestic water, sanitary, storm, gas, RODI, etc.) and other materials as required to describe the fundamental design concept for all plumbing systems <input type="checkbox"/> 2. Indication of the amount of redundancy for all major pieces of mechanical equipment, e.g. "two pumps 100% capacity each" <input type="checkbox"/> 3. Main water supply, storm, and sanitary leads <input type="checkbox"/> 4. Major equipment locations <input type="checkbox"/> 5. Restroom location(s) <input type="checkbox"/> 6. Plumbing legend	<input type="checkbox"/> 7. Updated design criteria for each plumbing system (including set points, water quality levels, etc.) <input type="checkbox"/> 8. Preliminary piping plans (domestic & process) with indication of required service access areas <input type="checkbox"/> 9. Meter locations <input type="checkbox"/> 10. Back flow prevention locations <input type="checkbox"/> 11. Fixture schedules, to include lab fixtures <input type="checkbox"/> 12. Equipment schedules (major equipment) <input type="checkbox"/> 13. Preliminary floor plans of mechanical rooms w/all components and required service access areas drawn to scale	<input type="checkbox"/> 14. Water riser diagram, including assumed fixture counts per floor connection <input type="checkbox"/> 15. Waste and vent riser diagrams including assumed fixture counts per floor connection <input type="checkbox"/> 16. Foundation drains <input type="checkbox"/> 17. Detailed piping design with all pipe sizes indicated <input type="checkbox"/> 18. Typical plumbing details, including structural support requirements <input type="checkbox"/> 19. Water heating piping details <input type="checkbox"/> 20. Penetration/sleeve details <input type="checkbox"/> 21. Design calculations
FIRE PROTECTION (MECHANICAL)	<input type="checkbox"/> 1. One-line diagrams for each fire protection system, and other materials as required to describe the fundamental design concept for all fire protection systems <input type="checkbox"/> 2. Report documenting adequacy of utility <i>(continued)</i>	<input type="checkbox"/> 7. Location of test headers and fire department connections <input type="checkbox"/> 8. Preliminary piping plans <input type="checkbox"/> 9. Preliminary floor plans of mechanical rooms w/all components and required service access areas drawn to scale <input type="checkbox"/> 10. Fire pump sizing calculations	<input type="checkbox"/> 11. Fire protect. service entrance details <input type="checkbox"/> 12. Fire protection plans (incl. header and riser layout) with indication of any required service access areas <input type="checkbox"/> 13. Detailed piping design with all major pipe sizes indicated <i>(continued)</i>

ITEM	SCHEMATIC PHASE	DESIGN DEVELOPMENT PHASE	CONSTRUCTION DOCUMENT PHASE
FIRE PROTECTION (MECHANICAL) (continued)	<input type="checkbox"/> 3. Connection to utility <input type="checkbox"/> 4. Location of fire pump and controller, jockey pump and sprinkler valves <input type="checkbox"/> 5. Sprinkler legend <input type="checkbox"/> 6. Optional F.P. systems		<input type="checkbox"/> 14. Location of all sprinkler zone valves, drains, and fire hose connections <input type="checkbox"/> 15. Zoning extents, for areas where the contractor will size the piping <input type="checkbox"/> 16. Typical sprinkler installation details, including structural support details <input type="checkbox"/> 17. Penetration/sleeve details <input type="checkbox"/> 18. Design calculations
LIGHTING	<input type="checkbox"/> 1. Electrical symbols legend <input type="checkbox"/> 2. General drawing notes <input type="checkbox"/> 3. General photometric levels <input type="checkbox"/> 4. Fixture, lamp, and controls descriptions <input type="checkbox"/> 5. Preliminary interior lighting plans <input type="checkbox"/> 6. Preliminary outdoor lighting plans	<input type="checkbox"/> 7. Typical interior lighting and control plans <input type="checkbox"/> 8. Outdoor lighting and control plans <input type="checkbox"/> 9. Fixture types and schedule <input type="checkbox"/> 10. Control system and control device descriptions <input type="checkbox"/> 11. Typical photometric calculations <input type="checkbox"/> 12. Dimming, daylighting and low voltage control zones	<input type="checkbox"/> 13. Interior and outdoor lighting plans, including control systems and devices, lighting panels, switching and circuiting <input type="checkbox"/> 14. Lighting control system schematics and wiring diagrams <input type="checkbox"/> 15. Lighting control system detailed sequences of operation <input type="checkbox"/> 16. Installation details, including structural support details <input type="checkbox"/> 17. Normal lighting photometric calculations <input type="checkbox"/> 18. Emergency lighting photometric calculations on 2' x 2' grid for State BFS approval <input type="checkbox"/> 19. General notes on conduit and wire sizes for 20 amp single phase lighting branch circuits
ELECTRICAL POWER DISTRIBUTION	<input type="checkbox"/> 1. Electrical demolition <input type="checkbox"/> 2. One-line and riser diagrams with equipment ratings <input type="checkbox"/> 3. Manhole, duct bank, and building entry locations <input type="checkbox"/> 4. Exterior equipment locations <input type="checkbox"/> 5. Substation, generator and ATS descriptions <i>(continued)</i>	<input type="checkbox"/> 9. Manhole, duct bank, and building entry plans and details <input type="checkbox"/> 10. Normal power riser diagram with circuit breaker, fuse, conduit and wire sizes <input type="checkbox"/> 11. Emergency power riser diagram with circuit breaker, fuse, conduit and wire sizes <input type="checkbox"/> 12. Grounding riser diagram <i>(continued)</i>	<input type="checkbox"/> 22. Details of power service to building <input type="checkbox"/> 23. Detailed power plans, including primary cable raceways, feeder conduits, electrical loads, duplex and special receptacles, and circuiting <input type="checkbox"/> 24. Emergency power system plans, controls, and details <i>(continued)</i>

ITEM	SCHEMATIC PHASE	DESIGN DEVELOPMENT PHASE	CONSTRUCTION DOCUMENT PHASE
ELECTRICAL POWER DISTRIBUTION <i>(continued)</i>	<input type="checkbox"/> 6. Substation, generator, and electric room locations <input type="checkbox"/> 7. Preliminary substation and generator room plans <input type="checkbox"/> 8. Electrical load calculations based on watts/sf	<input type="checkbox"/> 13. Substation standard detail <input type="checkbox"/> 14. Substation front elevation <input type="checkbox"/> 15. List of equipment on emergency power <input type="checkbox"/> 16. Electrical load calculations <input type="checkbox"/> 17. Panel schedules <input type="checkbox"/> 18. Preliminary short circuit and protective device coordination study <input type="checkbox"/> 19. Electrical equipment location plans <input type="checkbox"/> 20. Typical electrical outlet location plans <input type="checkbox"/> 21. Plan for temporary power during construction.	<input type="checkbox"/> 25. Connections to other building systems, including fire alarm and HVAC systems <input type="checkbox"/> 26. Details of non-standard electrical installations <input type="checkbox"/> 27. Final short circuit, coordination and arc flash hazard study <input type="checkbox"/> 28. Conduit and wire sizes for services, feeders, and special branch circuits (other than 20 amp single phase) <input type="checkbox"/> 29. General notes on conduit and wire sizes for 20 amp single phase branch circuits <input type="checkbox"/> 30. Notes identifying locations of separate and shared neutrals <input type="checkbox"/> 31. MCC elevations <input type="checkbox"/> 32. Grounding details <input type="checkbox"/> 33. Roof, wall and floor penetration details
FIRE ALARM AND EMERGENCY COMMUNICATIONS	<input type="checkbox"/> 1. System descriptions <input type="checkbox"/> 2. FA and EC panel locations <input type="checkbox"/> 3. MOSCAD panel location <input type="checkbox"/> 4. Preliminary FA and EC device and appliance location plans	<input type="checkbox"/> 5. Riser diagrams <input type="checkbox"/> 6. Auxiliary panel, remote panel, device and appliance location plans including pull stations, smoke detectors, horns, speakers, strobes, etc. <input type="checkbox"/> 7. MOSCAD standard detail	<input type="checkbox"/> 8. Detailed FA and EC panel, device and appliance location plans including duct detectors, fire/smoke dampers, sprinkler flow and tamper switches, monitor and control modules, door hold-opens, door lock releases, etc. <input type="checkbox"/> 9. Strobe light candela ratings <input type="checkbox"/> 10. Risk analyses required by NFPA-72 <input type="checkbox"/> 11. General notes on conduit and wire sizes <input type="checkbox"/> 12. Details of connections to HVAC, fire pump, fire suppression, door hold-open, door lock, and MOSCAD systems <i>(continued)</i>

ITEM	SCHEMATIC PHASE	DESIGN DEVELOPMENT PHASE	CONSTRUCTION DOCUMENT PHASE
<i>FIRE ALARM AND EMERGENCY COMMUNICATIONS (continued)</i>			<input type="checkbox"/> 13. MOSCAD antenna location plans and installation details <input type="checkbox"/> 14. Detailed sequences of operation and/or alarm matrix
<i>COMMUNICATIONS (INCLUDING VOICE, DATA, & VIDEO SYSTEMS)</i>	<input type="checkbox"/> 1. Manhole, duct bank , and building entry locations <input type="checkbox"/> 2. Building Entrance (BE) and local Telephone Room (TR) locations <input type="checkbox"/> 3. Riser diagram <input type="checkbox"/> 4. Preliminary cable tray plans	<input type="checkbox"/> 5. BE and TR locations, sizes, and door swings <input type="checkbox"/> 6. Backboard locations in BE and TR's <input type="checkbox"/> 7. Raceway and grounding riser diagrams <input type="checkbox"/> 8. Conduit and cable tray plans with conduit and cable tray sizes <input type="checkbox"/> 9. Material cut-sheets <input type="checkbox"/> 10. List of equipment to share telecom rooms <input type="checkbox"/> 11. BE and TR heat loads <input type="checkbox"/> 12. Typical voice, data and video outlet location plans <input type="checkbox"/> 13. Emergency phone locations and types (wall or pedestal) <input type="checkbox"/> 14. Courtesy phone locations	<input type="checkbox"/> 15. Detailed voice, data and video outlet locations <input type="checkbox"/> 16. Details of telecommunications service to the building <input type="checkbox"/> 17. Floor box schedule <input type="checkbox"/> 18. Conduit, outlet box and floor box installation details <input type="checkbox"/> 19. Power outlet locations in the BE and TR's <input type="checkbox"/> 20. Locations of non-telecom equipment in the BE and TR's
<i>SECURITY (INCLUDING CCTV AND CARD ACCESS CONTROL SYSTEMS)</i>	<input type="checkbox"/> 1. System descriptions <input type="checkbox"/> 2. Panel locations <input type="checkbox"/> 3. Preliminary device location plans	<input type="checkbox"/> 4. Riser diagrams <input type="checkbox"/> 5. Equipment location plans <input type="checkbox"/> 6. Security office layout <input type="checkbox"/> 7. Card access control equipment closet layout and elevations	<input type="checkbox"/> 8. Detailed equipment location plans <input type="checkbox"/> 9. Equipment schedules <input type="checkbox"/> 10. Concealed and exposed raceways <input type="checkbox"/> 11. Wiring diagrams <input type="checkbox"/> 12. Installation details <input type="checkbox"/> 13. Detailed sequences of operation
<i>A/V AND SPECIAL SYSTEMS</i>	<input type="checkbox"/> 1. System descriptions <input type="checkbox"/> 2. Panel locations <input type="checkbox"/> 3. Preliminary device location plans	<input type="checkbox"/> 4. Riser diagrams <input type="checkbox"/> 5. Equipment descriptions <input type="checkbox"/> 6. A/V equipment location plans <input type="checkbox"/> 7. Clock and other equipment location plans	<input type="checkbox"/> 8. Detailed equipment location plans <input type="checkbox"/> 9. Equipment schedules <input type="checkbox"/> 10. Wiring diagrams <input type="checkbox"/> 11. Installation details (including cabinets, hangers, and connection boxes) <input type="checkbox"/> 12. Detailed sequences of operation

ITEM	SCHEMATIC PHASE	DESIGN DEVELOPMENT PHASE	CONSTRUCTION DOCUMENT PHASE
<i>OTHER GRAPHICS</i>	<input type="checkbox"/> 1. Renderings, models, or other graphics as necessary to clearly present concept	<input type="checkbox"/> 2. Updated renderings, models and graphics required only as appropriate for design development	<input type="checkbox"/> 3. Updated renderings, models and graphics required only as appropriate for construction document preparation
<i>COST</i>	<input type="checkbox"/> 1. Preliminary cost estimate. For projects with cost greater than \$500,000, use format described in UM Design Guidelines SID-P "Project Estimates"		
<i>NOTES</i>	<ol style="list-style-type: none"> <i>All movable furnishings and artwork are considered to be independent of the architectural design project.</i> <i>Submittals of deliverables for DD and CD phases are to be preceded by a complete response to UM review comments on the previous phase of design work.</i> <i>No individual volume of drawings is to exceed 25 lbs in weight. No individual specification book volume is to exceed three inches in thickness.</i> 		



- HOME
- ABOUT US
- PROJECTS
- MAPS & DETOURS
- MASTER PLANNING
- POLICIES & PROCEDURES
- SUSTAINABILITY
- SAFETY

- FOR U-M CLIENTS
- FOR VENDORS
- FOR U-M AEC STAFF

OUT TO BID

DESIGN GUIDELINES

CODES & REGULATORY AGENCIES

DESIGN DELIVERABLES

SUSTAINABILITY

SPECIAL INSTRUCTIONS TO DESIGNERS

SPECIAL BUILDING AREAS

OFFICE SPACE

TECHNICAL SECTIONS

STANDARD DETAILS

MASTER SPECIFICATIONS

PREFERRED MANUFACTURERS

HEALTH SYSTEM PROJECTS

EFFECTIVE DATE

BUILDING COMMISSIONING

CONTRACTS & AGREEMENTS

CONTRACTOR RESOURCES

OTHER LINKS

SUSTAINABILITY

[Sustainability for Design and Construction](#) provides criteria for sustainable design and LEED requirements.

[AEC Sustainability Master Plan](#) is a comprehensive document which communicates the methodology Architecture Engineering and Construction is employing to improve building design and construction sustainability at the University of Michigan.

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- SAFETY

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- FOR VENDORS
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DESIGN DELIVERABLES

SUSTAINABILITY

SPECIAL INSTRUCTIONS TO DESIGNERS

SPECIAL BUILDING AREAS

OFFICE SPACE

TECHNICAL SECTIONS

STANDARD DETAILS

MASTER SPECIFICATIONS

PREFERRED MANUFACTURERS

HEALTH SYSTEM PROJECTS

EFFECTIVE DATE

BUILDING COMMISSIONING

CONTRACTS & AGREEMENTS













CONTRACTOR RESOURCES

OTHER LINKS

SPECIAL INSTRUCTIONS TO DESIGNERS

Special Instructions to Designers contains instructions on a wide variety of general, cross-discipline topics, including codes to be followed, and building commissioning.

SECTION	LAST UPDATE	PREVIOUS REVISION
SID-A Building Envelope	August 2014	May 2014
Health System Projects only SID-A-H Design Guidelines for UMHHC Facilities		

SID-B Owner's Project Requirements and Basis of Design Documents 	May 2012	July 2011 
SID-C Compatibility with Existing Conditions 	May 2014	December 1991 
SID-D Energy and Water Conservation 	February 2014	July 2012 
Energy and Water Conservation Report Format – Projects \$2M to \$10M Construction Cost	July 2013	June 2011
Energy and Water Conservation Report Format – Projects Over \$10M Construction Cost	February 2014	July 2013
Energy Impact Statement	May 2010	
SID-E Substitutions 	May 2014	July 1990 
SID-F Codes and Regulatory Agencies has been renamed Codes and Regulatory Agencies .		
Health System Projects only SID-F-H Supplemental Codes & Regulatory Agencies for UMHC Facilities - This document has been combined into Codes and Regulatory Agencies and is no longer maintained separately		
SID-G Commissioning 	May 2012	March 2012 
Design-Phase Commissioning 	October 2012	
MEP Design Coordination 	October 2012	
Full Project Commissioning 	October 2012	
Project Commissioning for Small Projects 	October 2012	
SID-H Drawing and Construction Documents Standards 	June 2011	March 2009 
Health System Projects only SID-H-H Construction Documents for UMHC Facilities 		
SID-I Regulated and Hazardous Materials 	July 2008	July 2006 
SID-J University Provided Utilities 	July 2013	November 2005 
SID-K Sustainable Design and LEED® Requirements 	February 2014	May 2013 
SID-L Owner's Review 	May 2014	January 2008 
SID-M Special Requirements 	July 1992	
SID-N Standard Legends and Abbreviations – Removed June 2014	April 1991	
SID-O Recycling Materials 	March 2014	
SID-P Project Estimates 	May 2014	February 2006 
Health System Projects only SID-P-H Estimating Guidelines for UMHC Facilities 		
SID-Q Building Access Control 	April 2010	November 2009 
SID-R Fall Protection on Rooftops 	June 2010	
SID-S Sustainable Products Portfolio 	October 2010	August 2010 
SID-T Landscape Materials 	November 2012	November 2010 
Health System Projects only SID-U-H UMHC Patient and Staff Protection: Falls, Bariatrics, Low Vision and Ergonomics 		
Site Furnishings Standards Manual 	December 2010	
Stormwater Best Management Practices Manual 	December 2010	

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BUILDING ENVELOPE

Scope

Building envelopes shall effectively control moisture migration, heat transfer and air leakage. This Design Guideline highlights areas requiring special attention and consideration with respect to building envelope design. This guideline also includes the U-M Building Envelope design review process and requirements.

Related Sections

U-M Design Guideline Sections:

[SID-B Owner's Project Requirements and Basis of Design Documents](#)

[07500 Roofing Systems and Accessories](#)

[07920 Joint Sealants](#)

[08410 Aluminum Entrance and Storefront Systems](#)

[08520 Aluminum Architectural Windows](#)

[08800 Glazing](#)

[08911 Glazed Aluminum Curtain Wall](#)

Reference Documents:

[U-M Envelope Inspection Form](#)

ASTM E 783 Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors

ASTM E 2357 Test Method for Determining Air Leakage of Air Barrier Assemblies

ASTM E 2178 Standard Test Method for Air Permeance of Building Materials

Moisture Control

Moisture control shall be a primary consideration in the building envelope design of new buildings, additions and renovations. Moisture migration from bulk water, capillary water, vapor diffusion and air leakage shall be minimized. Perform the following tasks to ensure moisture control in the design of the building envelope:

- Confirm the location of the water table and soil conditions prior to the start of design. Moisture prevention and control for below-grade walls shall be designed for the water table location and soil conditions specific to the project site.
- Perform dew-point analysis of exterior wall assemblies for all new buildings, renovations adding a significant amount of insulation to the envelope and when moisture load generated within the space is expected to increase significantly. Confirm that materials will be above the dew-point and will not accumulate moisture on the conditioned side or the inside of the envelope assembly.
- Provide comprehensive detail drawings for windows, doors, skylights, stacks, ducts, and all other envelope penetrations that will protect the building from water infiltration.

- Ensure efficient shedding of rainwater and prevent moisture infiltration into wall constructions. Provide adequate drainage and ventilation systems (e.g. weep holes) to prevent the collection of water in wall cavities.
- Provide designs that accommodate special programming conditions which impact the building envelope (e.g. an interior with high relative humidity levels).

Thermal Performance

Thermal performance shall be considered in the design of the building envelope to control heat transfer through conduction, radiation, and convection.

- Prevent conductive heat loss caused by thermal bridging in foundation and framing members.
- Minimize convective thermal loss with the prevention of air leakage through windows, doors and other penetrations in the building envelope.
- Select glazing and roofing materials to minimize radiative heat loss.
- Minimize thermal heat gain and maximize occupant comfort by shading exterior windows and the building envelope.
- Consider the orientation, size and performance of fenestration to minimize solar radiation while balancing the amount of daylighting with the amount of heat loss.
- Ensure reduction of heat loss by including details and specifications that identify the type and thickness of insulation for exterior walls, floors, ceilings, and roof areas.
- Carefully select materials and design placement of air barriers to ensure air tightness of the building envelope.

Continuous Air Barrier

For all new building construction and additions design a fully continuous air barrier for the entire building envelope that is capable of controlling air leakage into and out of the conditioned spaces.

- Design the air barrier assembly to withstand positive and negative air pressures due to design wind pressures, stack effect and fan pressures.
- Pay particular attention to the design of the air barrier at joints and points of intersection of two different building materials to maintain continuity. The design shall have enough strength and flexibility to accommodate differential movement of material substrates.
- Design the air barrier to remain in continuous contact with its substrate material in the building envelope.
- Select durable materials for the air barrier assembly, that will last the lifetime of the building.

For additions, design a complete air barrier for the addition enclosure as described above. Where existing walls and/or roof construction abut the new addition, continue the air barrier through the wall or roof construction in order to prevent air leakage at the juncture between the new and old construction.

- U-M does not have a preference for a particular type of air barrier or air barrier assembly. Select materials which are listed by the Air Barrier Association of America. It is acceptable to have a combined air barrier and vapor retarder; however, when they are combined the barrier must be located on the inside of the thermal insulation of the building envelope (for projects in Michigan).

U-M Building Envelope Design Review

Projects with a scope of work related to above and/or below-grade building enclosure elements will undergo a building envelope design review process. This review process will evaluate the materials, components, systems, and assemblies that comprise the above and/or below-grade building enclosure. Building Envelope Design Review shall begin at Schematic Design and continue until the end of Bid Documents phase.

Schematic Design Phase

- Establish the building envelope performance goals with building occupants and U-M Design Manager.
- Include envelope description and performance goals in the Owner's Project Requirements and Basis of Design (OPR/BOD) documents.
- Promote the use of construction mock-ups and other quality assurance techniques and participate in the evaluation of building envelope mock-ups.

Design Development Phase

- Further develop BOD document to include a building enclosure design description of materials, components, systems, and assemblies that make up the building envelope.
- Conduct a minimum of one meeting during DD dedicated to the presentation of the building envelope design to U-M and, when hired by U-M, a Building Envelope Specialist (BES). At the meeting, present drawings and specifications that demonstrate the envelope design concept as it relates to thermal protection, moisture control, and air leakage.
- During the Owner's Review of the DD documents, the BES shall provide written comments on the envelope design. Respond to the comments per U-M's document review procedures.

Construction Documents Phase

- Update BOD document to clarify and expand on the design description of materials, components, systems, and assemblies that make up the building envelope.
- Complete detail drawings of all transitions, perimeter sealing around fenestrations, doors, and penetrations through the exterior walls by structural members, parapet walls, etc.
- Provide specifications that include instructions about prepping surfaces and any primers needed to insure proper adhesion of air barrier materials.
- Include language for coordination of all trades whose work impacts the continuity of the air barrier. Reference the Air Barrier specification section in all of the affected trades.

- Include in the specifications the requirement for a pre-installation meeting with mandatory attendance by all trades whose work is related to the envelope, insulation, and the air and moisture barriers.
- Conduct a minimum of one meeting during CD dedicated to the presentation of building envelope design to U-M and the BES. Present drawings and specifications that demonstrate the effectiveness of envelope systems in controlling moisture migration, heat transfer and air leakage.
- During the Owner's Review of the CD documents, the BES shall provide written comments on the envelope design. Respond to the comments per U-M's document review procedures.
- At the end of CD phase, the BES shall provide a project specific version of the U-M Envelope Inspection Form. Review project specific U-M Envelope Inspection Form and submit recommendations for additional inspections and tests to the U-M Design Manager.

Inspection and Testing of Building Envelope

U-M will employ independent specialists, inspectors and testing agencies for projects involving building envelope work. To understand what will be inspected refer to the U-M Envelope Inspection Form. Consult with Design Manager regarding the scope of testing for this project.

SID-A-H: DESIGN GUIDELINES FOR UMHC FACILITIES

This section is not currently used. For details on UMHC Design Guidelines, please click [here](http://www.med.umich.edu/facilities/plan/vn/dg/index.html) or go to <http://www.med.umich.edu/facilities/plan/vn/dg/index.html>

OWNER'S PROJECT REQUIREMENTS AND BASIS OF DESIGN DOCUMENTS

Scope

Beginning in the Schematic Design phase and continuing until the project has been as-built, the Architect/Engineer with input from the project team shall develop and periodically update an Owner's Project Requirements (OPR) document and a Basis of Design (BOD) document. These two documents together shall provide a complete description of the project's design intent. They may be submitted for Owner's review as two separate sections of one design intent document.

The OPR is an inclusive, detailed description of the Owner's goals and requirements for the project, and the Owner's expectations on how the project will be used and operated.

The BOD is an inclusive, detailed description of the Design Team's concepts, assumptions, calculations, decisions, product selections and operating conditions to meet the Owner's project requirements and to satisfy applicable codes, standards and guidelines. It shall be formatted to coordinate with and respond to the OPR.

These two documents will be benchmarks by which the completeness, adequacy and acceptability of the project will be judged. They will be the standards by which the project will be commissioned. They will answer Owner questions after occupancy, and they will be the foundation for maintenance programs and future renovation projects.

Related Sections

U-M Design Guideline Sections:

[SID-D - Energy and Water Conservation](#)

[SID-G - Commissioning](#)

[SID-K - Sustainable Design and LEED® Requirements](#)

[SID-L - Owner's Review](#)

Reference Documents:

ASHRAE Guideline 0-2005, "The Commissioning Process"

USGBC, "LEED® Reference Guide for Green Building Design and Construction"

USGBC, "LEED® Reference Guide for Building Design and Construction - Healthcare"

Execution

Contents

The OPR shall include at least the following information:

- Summary description of the building (functions of building, high or low rise, use and occupancy classifications, anticipated hours of operation, etc.).
- Project goals, assumptions, and known limitations.
- Donor and Sponsor program requirements.
- Building and site accessibility, architectural, landscaping and aesthetics goals.
- Building and site flexibility and expandability requirements (spare capacities, survivability, reliability, redundancy, back-up power and utilities, etc.).

SID-B

- Operational assumptions (maximum occupancy on a room-by-room and aggregate basis), occupancy schedules, special activities, building diversity, potential future uses, potential future renovations, etc.).
- Building envelope performance criteria.
- Environmental and sustainability goals.
- Energy and water conservation goals.
- Indoor services and technology requirements (clean room and bio-safety lab classifications, fume hood sizes and types, vivarium and environmental room conditions, furniture, marker boards, process water, gases, communications, data, security, card access control, audio/visual, etc.).
- Space-by-space design requirements (temperature, humidity, air change rates, room pressurization, sound level limits, light levels, glare limits, vibration criteria, EMF shielding, etc.).
- Space-by-space equipment heat loads and utility needs (water, gases, power, data, grounding, etc.).
- Anticipated types, classifications, and quantities of hazardous materials to be contained within the building.
- Architectural, mechanical and electrical systems operation and maintenance expectations.
- HVAC, lighting and audio/visual controls expectations.
- Summary of sole-sourced systems and equipment.
- Summary of Owner-furnished and Owner-installed equipment.
- Occupant and Maintenance training requirements.
- Project schedule.
- Project budget (UniFormat cost estimate). The U-M Design Manager will determine whether budget information should be included in the OPR or provided separately.

The BOD shall include at least the following information:

- Project background required to understand the design, including goals, requirements and decisions which significantly affect the design.
- Regulatory, site, schedule and budget limitations which affect the design.
- Codes, standards and guidelines applicable to the project.
- Code analysis describing code requirements specific to the project, e.g. smoke evacuation systems, if manifolded exhaust is permitted, special fire protection requirements, etc.
- Requirements of governing agencies (City, State, NIH, LEED, etc.).
- Climate, site, and utilities information.
- Architectural, mechanical and electrical systems descriptions (construction classifications, design loads, fire separations, base and spare capacities, diversity and reliability assumptions, redundancy, flexibility, back-up power, sub-metering, etc.).
- Outdoor summer and winter design conditions.
- Design assumptions (occupancy schedules, temperature, humidity, air change rates, room pressurization, sound level limits, light levels, glare limits, vibration criteria, EMF shielding, heat loads, water, gases, power, data, grounding, hazardous materials being stored, etc. for spaces not indicated in the OPR.
- Systems and equipment sequences of operation.
- Load calculations descriptions, including assumptions, software used, etc.

SID-B

- Architectural, mechanical and electrical systems operation and maintenance requirements.
- Facility Condition Assessment list marked to indicate tasks included in the project.
- Appendices
 - Documentation of compliance to SID-D (see SID-D Appendices A and B for the Energy and Water Conservation Report standard format).
 - Energy Impact Statement (see SID-D Appendix C for the Energy Impact Statement standard format).
 - LEED Checklist when required by SID-K.
 - Soils and utility services reports.
 - Building load calculations.
 - Systems and equipment sizing calculations.
 - Light level and watts/square foot calculations.
 - Effluent, dispersion, noise, vibration, and other studies.

Development and Updating

Develop the OPR and BOD by expanding the project's program and design concept report. Update them as the project goals and requirements are defined and clarified. Submit them at the end of the Schematic Design, Design Development and Construction Document phases along with the other Design Deliverables. Submit a final BOD after Project Award and after incorporation of the bid alternates. Each update shall incorporate new and revised project information including:

- Progress in project design.
- Changes in project goals.
- Changes in project scope.
- Code interpretations.
- Input from Occupants, Construction Managers and Contractors.
- Input from Plant Operations, Department of Public Safety, OSEH, etc.
- Architectural, mechanical and electrical design coordination meetings.
- Value engineering sessions.
- Test reports on existing conditions.
- Design calculations.
- Equipment selections.
- The final power system short circuit, protective device coordination and arc flash hazard study including the electronic data file for long term updating by the Owner.
- Energy and water conservation calculations and modeling.
- Updates to LEED Checklist.
- Sound, effluent, dispersion, CFD, vibration, and other studies.
- Bid Alternates and Owner's Options.
- A list of all design deviations from U-M Design Guideline requirements.
- A list of all uncompleted Facility Condition Assessment (FCA) items within the project boundary.

Format

SID-B

Organize the OPR and BOD on a system-by-system basis, preferably in order by CSI Division, using a consistent style for each section. Organize each section from the more global to the more detailed and specific. Number each section and subsection in outline format. Provide a Table of Contents. Submit an electronic file copy along with the required number of printed copies.

As-Built BOD

At the conclusion of the project, the U-M Design Manager may elect to have the final BOD updated with as-built information. The means and methods for this effort will be negotiated by the Design Manager on a project-by-project basis.

To facilitate the production of an as-built BOD document, identify changes during construction that impact the final BOD and notify the U-M Design Manager accordingly. When writing addenda, CCD's and RFI's, mark them with "Impact on BOD" if they affect the BOD.



COMPATIBILITY WITH EXISTING CONDITIONS

Related Documents

U-M Design Guidelines:

[SID-J - University Provided Utilities](#)

[SID-I Regulated and Hazardous Materials](#)

Existing Conditions

A/E responsibilities:

- Review original building and renovation drawings located in the AEC Facilities Information Center (FIC).
- Visit the site prior to start of design to determine existing conditions. Review University provided Facility Condition Assessment (FCA) report with Design Manager for inclusion in project scope.
- Base design upon the actual conditions, not original or renovation design drawings and specifications.
- Update riser diagrams.
- If upgrading of the central system is necessary to meet the new needs, this information shall be given to the Design Manager
- University of Michigan Hospitals and Health Centers (UMHHC) Facilities Planning and Development
 - Contact UMHHC Facilities Planning for record documents (“as built”) of UMHHC buildings.
 - UMHHC Building keyplans are available on the [Facilities Planning website](#). Please contact Facilities Planning for password access.
 - UMHHC Facilities Planning and Development maintains a set of PDF keyplans on the website to record any corrections. When an error is found on as-builts FPD requests that a comment is made on the PDF utilizing Adobe and an email sent to FAC-ProjectDept@med.umich.edu noting the corrections.

Utility Sources

Utilize central utilities and building systems in lieu of stand-alone systems. Coordinate with the Design Manager early in the design phase of the project to determine the best sources for central services. The Design Manager will coordinate approval of sources prior to schematic design.

Utility Capacity

As part of schematic design, demonstrate that the proposed project will not adversely affect utility availability for existing users, nor utilize inordinate amounts of future capacity. When a utility is upgraded, provide for other planned consumers.

Determine available capacity early enough in the planning / schematic design process for funding to be allocated within the renovation project for increased services if needed.

Existing Condition Assessment

As a part of schematic design, the Design Manager will provide a listing of any outstanding code deficiencies in areas to be renovated for incorporation into the project. Additional items uncovered during surveys and site visits are to be brought to the attention of the Design Manager who will seek funding for incorporation of such items into the project.

Construction documents should include firestopping / patching of all existing and new openings in fire and acoustical separations to maintain performance of the system. Infill material shall match fire and / or acoustical properties of existing partition for continuity.

Existing Hazardous Materials

Design Manager shall provide surveys of existing building materials establishing the presence of hazardous materials such as lead and asbestos. The surveys will be obtained from University of Michigan OSEH, Occupational Safety and Environmental Health. A/E shall include surveys in construction documents if there is hazardous material present. Design Manager shall coordinate with A/E and OSEH for process for removal of materials.

ENERGY AND WATER CONSERVATION

Related Sections

U-M Design Guideline Sections:

[SID-B - OPR/BOD \(Owner's Project Requirements/Basis of Design\) Document](#)
[15910 - Laboratory Ventilation](#)

Related Documents:

[Energy and Water Conservation Report Format-Projects \\$2M to \\$10M Construction Cost](#)
[Energy and Water Conservation Report Format-Projects Over \\$10M Construction Cost](#)
[Energy Impact Statement Format and Examples](#)

Reference Documents:

ASHRAE 90.1-2007, "Energy Standard for Buildings Except Low-Rise Residential Buildings"
ASHRAE 189.1-2009, "Standard for the Design of High-Performance Green Buildings"
ASHRAE Handbook-2007, "HVAC Applications"

Summary

This Design Guideline applies to new buildings, building additions, building alterations and capital equipment replacements at the Ann Arbor, Dearborn and Flint campuses. Contact the Project Design Manager to determine when it applies to leased properties.

Consider energy and water conservation in all aspects of project design. Incorporate conservation measures as described herein and as requested by the Design Manager.

Throughout the design process, meetings shall be held to evaluate how the project is meeting the project's conservation targets and to review the conservation measures specific to the project.

Energy Conservation Compliance

All projects

- (a) Comply with ASHRAE Standard 90.1-2007.
- (b) Incorporate the Mandatory Energy Conservation Measures (ECMs) listed herein.
- (c) Evaluate the Potential ECMs listed herein and incorporate as appropriate.
- (d) Incorporate the Water Conservation Measures listed herein.

Projects between \$2M and \$10M construction cost

In addition to the requirements applicable to all projects, perform the following:

- (a) Comply with the Mandatory Provisions of ASHRAE 90.1 and utilize either the Prescriptive Path or the Energy Cost Budget (ECB) method.
- (b) Utilize the United States Department of Energy's (DOE) *COMcheck* software (<http://www.energycodes.gov/comcheck/>) to demonstrate compliance.
- (c) Document the impact of the ECMs in accordance with the Documentation Requirements listed herein.

Projects over \$10M construction cost

In addition to the requirements applicable to all projects, perform the following:

- (a) Exceed ASHRAE 90.1 baseline requirements by 30 percent (design for a total annual energy cost at least 30 percent below that of an ASHRAE 90.1 baseline building). Projects unable to meet this requirement shall apply for a variance from the Associate Vice President for Facilities and Operations.
- (b) Utilize the United States Department of Energy's *COMcheck* software to demonstrate compliance to the Mandatory Provisions of ASHRAE 90.1.
- (c) In accordance with Appendix G: Performance Rating Method of ASHRAE 90.1, use a computer energy simulation program to establish a baseline energy consumption for the entire building and to calculate the percentage energy cost saved above the baseline.
- (d) Document the impact of the ECMs in accordance with the Documentation Requirements listed herein.
- (e) Provide an Energy Impact Statement as described herein.

Mandatory Energy Conservation Measures

The following ECMs shall be incorporated into every project as applicable to the project's scope.

- (a) Window Blinds/Shades: Provide interior blinds/shades on south and west facing windows.
- (b) Occupancy Schedules: Determine anticipated occupancy schedules in consultation with the Users and indicate these in the OPR/BOD Document, in the Energy Impact Statement, and in the energy simulation software output. Based on these schedules, indicate on the project control drawings the initial operating schedule for all mechanical and electrical systems and equipment.
- (c) Part Load Efficiency: Design mechanical and electrical systems to run efficiently at partial loads.
- (d) HVAC System Zoning: Zone HVAC systems by occupancy type, ventilation rate, and operating schedule to allow shutdown or setback during no/reduced occupancy. Utilize zoned shutdown for sections of systems where occupancy schedules vary widely and separate systems are not feasible.
- (e) DDC VAV Control: Control room air volume and temperature with direct digital controlled variable air volume (VAV) assemblies.

- (f) Standalone HVAC Systems: Provide standalone HVAC systems for areas that require 24/7 operation, to allow central systems to be shut down.
- (g) Laboratories: See U-M Design Guideline 15910 Laboratory Ventilation for information regarding ECMs in labs.
- (h) Building Envelope Thermal Scanning: For projects over \$10M construction cost, perform infrared thermal scans of any existing envelope during design to identify areas needing improvement. Perform scans of the new building envelope during construction. Correct deficiencies found.
- (i) Incandescent Lighting: Limit incandescent lighting to accent or special use.
- (j) Lighting and Power Justification: Provide justification for any area that exceeds ASHRAE 90.1 lighting or electrical power limits.

Mandatory Evaluations of Potential Energy Conservation Measures

Evaluate the following ECMs in accordance with the Economic Evaluation of Energy Conservation Measures section of this Design Guideline. Incorporate any ECM into the project that meets the maximum payback criterion.

- (a) Below-Grade Insulation: Improve the below-grade insulation R-value above the ASHRAE 90.1 required minimum.
- (b) Wall Insulation: Improve the wall insulation R-value above the ASHRAE 90.1 required minimum.
- (c) Roof Insulation: Improve the roof insulation R-value above the ASHRAE 90.1 required minimum.
- (d) Glazing: Provide glass with reduced solar heat gain coefficients and fenestration systems with lower U values than the ASHRAE 90.1 required maximums.
- (e) Server Rooms: Instead of electronic data server rooms located inside the project building, consolidate servers into data centers located outside of the project building.
- (f) Chillers: Exceed ASHRAE 90.1 chiller efficiency. Include the impact of pump power reductions.
- (g) Free Cooling: Where there is a year-around chilled water load in the building, use “Free Cooling” as part of the chilled water system. Free Cooling shall utilize an evaporative cooling tower coupled with a heat exchanger, closed circuit evaporative fluid coolers, or dry coolers to produce chilled water when seasonal temperatures permit. Evaporative towers should be separate or be able to be decoupled from the main cooling tower array.
- (h) Heat Recovery: Where an air handling system’s minimum outside air percentage is greater than 40 percent, use a heat recovery system to transfer heat from exhausted air to the outside air entering the system. Evaluate heat recovery (enthalpy) wheels, flat plate air-to-air heat exchangers, heat pipes (including pumped type), and run-around coils. Include the impact of additional pressure drop through each device type.
- (i) Envelope Inspections: Increase the inspection of the exterior wall insulation and exterior fenestration systems. Energy savings evaluation to be based on a percentage reduction of the estimated annual energy consumed due to infiltration and thermal conduction through the building envelope.

- (j) Lighting Controls: Where occupancy in auditoriums, classrooms, conference rooms and offices varies with time of day, provide occupancy sensing and day-lighting control to achieve minimum space lighting times and ventilation rates, and close VAV boxes to zero position if no occupancy is detected.
- (k) Boilers: Exceed ASHRAE 90.1 boiler efficiency.
- (l) HVAC: Exceed ASHRAE 90.1 mechanical cooling and heating equipment efficiencies.
- (m) Kitchen Hoods: Provide variable volume kitchen exhaust hood systems.

Additional Energy Conservation Opportunities

Consider additional energy conservation opportunities including those listed below for application on the project.

- (a) Optimum building aspect ratios (squareness and roof area vs. total area).
- (b) Optimum building siting to respond to the climate. Minimize west and south facing windows. Optimize glass orientation and area. Consider double glass wall systems for south or west facades with large areas.
- (c) Fenestration overhangs, setbacks, fins, or similar exterior shading devices.
- (d) Light shelves to promote day lighting.
- (e) Clerestories to reduce energy use while providing day-lighting, in lieu of horizontal glass surfaces or large windows.
- (f) Fritted glass, in particular for atriums, winter gardens, and similar type spaces with roofs containing a large percentage of glass.
- (g) For renovation projects where fenestration or glazing will not be replaced, consider window films to improve energy performance.
- (h) Vegetated roofs.
- (i) Improved ventilation air flow efficiency by reducing the pressure drop of air system components and ductwork. In particular, consider for air systems that run continuously 24/7.
- (j) Chilled beams for areas with large sensible loads and moderate ventilation air requirements.
- (k) Displacement/impingement ventilation systems for large spaces with high ceilings.
- (l) Heat recovery systems that recover heat from heat rejection equipment or from other available “waste” heat in the building.

Economic Evaluation of Energy Conservation Measures

It is the intent that ECMs incorporated by the project will have payback periods less than the maximum payback periods stated below. It is recognized however that projects may need to incorporate some ECMs with longer than the maximum payback periods in order to exceed ASHRAE 90.1 by 30 percent.

ECM Simple Payback Calculations and Criterion

Evaluate the financial metrics of each ECM.

- (a) Calculate the simple payback period of each ECM using:

Simple Payback Period =

$$\frac{\text{Incremental Capital Cost of the ECM}}{\text{Annual Energy Savings} - \text{Incremental Maintenance Costs of the ECM}}$$

- (b) Determine the service life of each ECM in accordance with the ASHRAE Handbook Chapter 36, “Costs of Owning and Operating Equipment.” For ECMs not covered in the ASHRAE Handbook, contact the Design Manager for U-M input on their service lives.
- (c) Where the service life of two alternative systems is significantly different from each other, include the replacement cost of the shorter lived system in the analysis.
- (d) Use the following table to determine whether each ECM meets the maximum simple payback criterion and should or should not be incorporated.

Service Life of ECM (years)	Maximum Simple Payback Period (years)
15	6
20 or More	8

- (a) For fenestration and glazing, use a maximum simple payback period of 10 years. For membrane roof insulation, use 12 years. For all other insulation, use a maximum simple payback period of 30 years.

Energy Calculations

Utilize a computer energy simulation program for energy use calculations that meets the requirements of ASHRAE 90.1.

Energy Costs

When evaluating ECMs, use the current utility costs available at http://www.plantops.umich.edu/utilities/Utilities/utility_rates.php.

Maintenance Costs

Include significant maintenance cost impacts if anticipated as a result of an ECM. Submit a comparative equipment list detailing the two options being analyzed to the Design Manager and request the necessary maintenance unit and annual costs.

Water Conservation Compliance

All projects

- (a) Incorporate water conservation measures that in aggregate use 20 percent less water than a baseline water use (not including irrigation) based on Energy Policy Act of 1992 fixture performance requirements (which are incorporated into the Michigan Plumbing Code).
- (b) Incorporate the following mandatory water conservation measures:
 - Dual flush water closets.
 - Waterless or 1/8 gallon per flush urinals.
 - 2 GPM shower heads.
- (c) Incorporate additional measures as required to meet the 20 percent water conservation target. (1/2 GPM aerators for lavatory faucets are required by the plumbing code and thus may not be used as a credit toward the 20 percent target.)
- (d) Document the impact of the Water Conservation Measures in accordance with the Documentation Requirements listed below.

Documentation Requirements

Provide documentation in accordance with Design Guideline SID-B, the Design Deliverables and as follows.

When using the Energy and Water Conservation Report Format form, assure hidden text is turned “on” and carefully review additional information and guidance notes.

Projects between \$2M and \$10M construction cost

Starting at the Schematic Design (SD) phase and expanding during the Design Development (DD) and Construction Documents (CD) phases, provide the following information utilizing the Energy and Water Conservation Report Format form provided as a Related Document.

- (a) A copy of a completed COMcheck compliance report.
- (b) If the ECB method is used, a summary of the computer energy simulation software output and a narrative explaining how compliance was attained using the ECB method.
- (c) Explanation of all ECMs evaluated for the project. Provide summary calculations demonstrating the simple payback period of each measure.
- (d) Explanation of all Water Conservation Measures applied to the project and their predicted results.
- (e) Explanation of which Mandatory Energy Conservation Measures and Mandatory Energy Evaluations apply to the project and how they will be implemented.

Update the CD phase report after project award to reflect accepted Alternates and Owner's Options.

Projects over \$10M construction cost

As part of the program and concept design report, identify the architectural, mechanical, and electrical energy conservation technologies specific to the project that will be utilized to provide a building that exceeds ASHRAE 90.1 baseline requirements by 30 percent or more.

Provide the following information utilizing the Energy and Water Conservation Report Format form provided as a Related Document.

During the Schematic Design Phase, provide:

- (a) Calculated values for the *baseline building performance*. The *proposed building performance*, and the percentage improvement is also strongly preferred but is not required at SD Phase.
- (b) A copy of the completed COMcheck compliance report demonstrating compliance to the Mandatory Provisions of ASHRAE 90.1.
- (c) Complete data files from the energy simulation program including a breakdown of energy usage by at least the following components: lights, internal equipment loads, service water heating equipment, space heating equipment, space cooling and heat rejection equipment, fans, and other HVAC equipment (such as pumps). The output reports shall also show the amount of time any loads are not met by the HVAC system for the *baseline building design* and the *proposed building design*. The proposed building design shall not have more “unmet hours” than the baseline building.
- (d) An explanation of any error messages noted in the simulation program output.
- (e) Explanation of which Mandatory Energy Conservation Measures and Mandatory Energy Evaluations apply to the project and how they will be implemented.
- (f) Explanation of all other ECMs to be applied to the project. Include summary calculations demonstrating the simple payback period of each measure (see the "Economic Evaluation of Energy Conservation Measures" section of this Guideline). List ECMs planned for the *proposed building design* and indicate the relative contribution each will make toward attaining the required 30 percent improvement over ASHRAE 90.1. This list shall document all energy features that differ between the *baseline building performance* and the *proposed building performance* calculations.
- (g) Explanation of all Water Conservation Measures applied to the project and their predicted results.

During the Design Development and Construction Document phases, provide:

- (a) Calculated values for the baseline building performance, the proposed building performance, and the percentage improvement.
- (b) Updates of all the energy and water conservation documentation required to be submitted at the SD phase.

Update the CD phase report after project award to reflect accepted Alternates and Owner's Options.

Energy Impact Statement

For projects over \$10M construction cost, provide an Energy Impact Statement. Utilize the form provided as a Related Document.

ENERGY AND WATER CONSERVATION REPORT FORMAT PROJECTS BETWEEN \$2M AND \$10M CONSTRUCTION COST

2013-07-15: Revised to require yearly savings of KWH and Therms be reported, for DTE energy incentive programs.

Utilize the following report format to indicate compliance to U-M Design Guidelines Special Instructions to Designers SID-D. Supplemental narratives and tables may be provided in addition to the information required below, but for the required tables indicated below, do not change the table explanations, format, headings, footnotes, or the order in which the tables are presented. The data in the tables in this sample report is for illustrative purposes only, update to project specific values.

Cover Page

Provide a cover page with the project name, project number, date and report version: SD, DD, CD, or FINAL. Provide similar information in the report footer.

Executive Summary

Energy conservation measures (ECMs) were evaluated per the requirements of U-M Design Guidelines Special Instructions to Designers SID-D. The total estimated cost savings and first cost of the recommended ECMs for this project are summarized below:

Estimated Annual Energy Cost Avoidance w/ECMs:	\$152,300
Total Estimated First Cost of ECMs:	\$1,210,000
Over-all Simple Payback (years):	7.9

The estimated savings in energy units, reported below, is useful for utility incentive programs. When reporting this information, do not convert electrical energy savings to equivalent therms, or gas savings to equivalent KWH.

KWH/Year Savings:	XXXXX
Therms/Year Savings:	XXXXX

A requirement of U-M Design Guidelines Special Instructions to Designers SID-D is for designs to use 20% less water compared to designs that exactly meet the building code. The estimated water savings for this project are summarized below:

Estimated Total Annual Water Savings:	41,000 gallons
Annual Water use w/o Water Conservation Measures:	200,000 gallons
Percent Savings Versus Code Requirement:	21%

Project: *<insert project name>*

Report Version: *<insert SD, DD, CD, or FINAL>*

Page 1

Table 1: Summary of ECM Evaluations

Table 1 summarizes every energy conservation measure evaluated by the design team for this particular project, along with various ECM financial metrics.

Table 1: Summary of ECMs Evaluated

ECM No.	Description	First Cost Estimate	Annual Costs Savings	Simple Payback	ROI	Persistence ¹ H/M/L	Accepted Yes/No	Comments
1a	Additional 0.75" Wall Insulation	\$180,000	\$14,000	12.9	7.8%	H	N	
1b	Additional 1" Wall Insulation	\$300,000	\$16,500	18.2	5.5%	H	N	
1c	Additional 1.5" Wall Insulation	\$350,000	\$18,400	19.0	5.3%	H	Y	
2a	Glass SHGC =0.38	\$186,000	\$7,500	24.8	4.0%	M	N	
2b	Glass SHGC =0.33	\$190,000	\$8,000	23.8	4.2%	M	Y	
2c	Argon Filled Triple Glazed Glass SHGC = 0.26	\$265,000	\$13,400	19.8	5.1%	L	N	Seal life guaranteed only 10 years. Slight gray tint.
3	Day Lighting Sensors, Atrium	\$42,000	\$12,000	3.5	28.6%	M	Y	
4	Desiccant Wheel	\$200,000	\$40,000	5.0	20.0%	M	Y	
5	Exterior Shades, South Façade	\$78,000	\$15,000	5.2	19.2%	H	Y	
6	Increase Thermostat Deadband	\$0	\$7,000	N/A	N/A	L	Y	
7	Free Cooling Process Load	\$350,000	\$55,000	6.4	15.7%	H	Y	
8	Shower Heat Recovery Device	\$24,000	\$3,000	8.0	12.5%	L	N	Maintenance issues

Note 1: Persistence represents an opinion of the probability that the estimated energy savings will be fully realized.

Table 2: Water Conservation Measures and Predicted Results

Table 2 indicates the water saving measures and resulting percent water savings predicted for this project versus a project constructed to meet building code requirements (building code requirements are based on Energy Policy Act of 1992 fixture performance dictates). The requirement of U-M Design Guidelines Special Instructions to Designers SID-D is for designs to provide projects that use 20% less water than projects designed to exactly meet the building code.

Table 2: Water Conservation

Water Conservation Measure	Estimated Annual Savings (Gallons)
Dual Flush Water Closets	7,000
Waterless or 1/8 Gallon Per Flush Urinals	5,000
HVAC Condensate Used For Cooling Tower Make-Up	8,000
2 GPM Shower Heads	12,000
Gray Water Recovery	9,000

Estimated Total Annual Water Savings: 41,000

Annual Water use w/o Water Conservation Measures: 200,000

Estimated Percentage Savings: 21%

Tables 3 and 4:

U-M Design Guideline Special Instructions to Designers SID-D requires that all projects implement certain "mandatory" energy conservation measures, and it requires that other energy conservation measures be "evaluated" for every project. Tables 3 and 4 indicate which of the mandatory and evaluated measures were found applicable to the project.

Table 3: Review of Mandatory Energy Conservation Measures

Mandatory ECM No.	Description	Implemented Yes/No	Comments	ECM Cross Ref.
a	Window Blinds/Shades	Y		ECM 9
b	Occupancy Schedules	Y		
c	Part Load Efficiency	Y		
d	HVAC System Zoning	Y		ECM 8
e	DDC VAV Control	Y		
f	Standalone HVAC Systems	N	No process areas.	
g	Laboratory ECMs	N	Not a lab building.	
h	Building Envelope Thermal Scanning	Y		ECM 4
i	Limit Incandescent Lighting	Y		
j	Lighting and Power Justification	N		

Project: <insert project name>

Report Version: <insert SD, DD, CD, or FINAL>

Table 4: Review of Mandatory Energy Evaluations

Mandatory Evaluation No.	Description	Implemented Yes/No	Comments	ECM Cross Ref.
a	Additional Below-Grade Insulation			
b	Additional Wall Insulation			
c	Additional Roof Insulation			
d	Improved Glazing (1)			
e	Eliminate Server Rooms			
f	High Efficiency Chiller (1)			
g	Free Cooling			
h	Heat Recovery			
i	Increased Envelope Inspections			
j	Occupancy/Daylight Sensing			
k	High Efficiency Boiler (1)			
l	High Efficiency HVAC Equipment (1)			
m	Variable Volume Kitchen Hoods			

Note 1: Performance/efficiency better than required by code.

Table 5: Energy Cost Assumptions:

Table 5 reports the energy cost assumptions utilized for energy cost calculations.

Table 5: Energy Costs Assumptions

Energy Type	Cost	Comments
Electricity	\$0.079 /kwh	DTE Direct Purchase Rate
Natural Gas	\$0.842/therm	MichiCon Direct Purchase Rate
District Steam	\$1.90/therm	U-M Utility Rate
District Chilled Water	\$1.07/therm	U-M Utility Rate

Attach the following to this report in the order indicated:

- *Completed COMcheck compliance report demonstrating compliance to ASHRAE Standard 90.1.*
- *If the ECB method is used, complete data files from the energy simulation program. Include the name of the simulation program(s) used. The output reports shall also show the amount of time any loads are not met by the HVAC system for the baseline building design and the proposed building design. The proposed building design shall not have more “unmet hours” than the baseline building.*
- *An explanation of any error messages noted in the simulation program output.*

Project: <insert project name>

Report Version: <insert SD, DD, CD, or FINAL>

ENERGY AND WATER CONSERVATION REPORT FORMAT PROJECTS OVER \$10M CONSTRUCTION COST

2013-07-15: Revised to require yearly savings of KWH and Therms be reported, for DTE energy incentive programs.

Utilize the following report format to indicate compliance to U-M Design Guidelines Special Instructions to Designers SID-D. Supplemental narratives and tables may be provided in addition to the information required below, but for the required tables indicated below, do not change the table explanations, format, headings, footnotes, or the order in which the tables are presented. **The data in the tables in this sample report is for illustrative purposes only, update to the project specific values.** Provide a cover page with the project name, project number, date and report version: SD, DD, CD, or FINAL. Provide similar information in the report footer.

Executive Summary

Energy conservation measures (ECMs) were evaluated using ASHRAE 90.1 Appendix G procedures. Appendix G requires estimated savings be compared to a *Baseline Building* that exactly meets ASHRAE 90.1 energy code requirements. U-M Design Guidelines require projects reduce energy cost by 30% compared to the ASHRAE 90.1 *Baseline Building*.

The version of the ASHRAE standard that this project was evaluated against was ASHRAE 90.1-XXXX <insert year>

The estimated total annual cost savings by implementing the recommended ECMs is <insert dollars>, which is equivalent to an annual percent savings of <insert percentage> compared to a ASHRAE 90.1 *Baseline Building*.

The estimated total annual water savings by implementing the recommended water conservation measures is <insert gallons>, which is equivalent to an annual percent savings of <insert percentage> compared to a building complying with the Michigan Plumbing Code.

Table 1: Recommended ECMs (ECM Interactions Not Accounted For)

Table 1 lists all the ECMs that are recommended for implementation on this project. It indicates the savings potential for each ECM without regard to the impact ECMs may have upon one another. Because of such "interactions", the actual cost savings for some ECMs will be less than when they are analyzed on a stand-alone basis. For example, the savings from an ECM that reduces lighting energy will be partially offset by increased space heating requirements due to less light energy heating the space. Table 2 accounts for such ECM interactions.

Table 1: Recommended ECMs (ECM interactions not accounted for)

ECM No.	Description	Dollars/Year Savings	First Cost
1c	Increase Wall Insulation to 2.75"	\$18,400	\$350,000
2b	Improved Window Performance, SHGC = 0.33, U = 0.44	\$8,000	\$190,000
3	Day Lighting Sensors, Atrium	\$12,000	\$42,000
4	Desiccant Wheel	\$40,000	\$200,000
5	Exterior Shades, South Façade	\$15,000	\$78,000
6	Increase Thermostat Deadband	\$7,000	\$0
7	Install Free Cooling System	\$55,000	\$350,000

Total First Cost:

\$1,210,000

Project: <insert project name>

Report Version: <insert SD, DD, CD, or FINAL>

Total Savings (no interactions accounted for): \$155,400

Table 2: Summary ECM Savings (with ECM Interactions)

Table 2 reports the total estimated ECM savings with ECM interactions taken into account. Where combinations of ECMs are listed, it indicates that those ECMs interact with one another and therefore had to be analyzed as a group.

Table 2: Summary ECM Savings (with ECM interactions)

ECM No.	Description	Dollars/Year Savings
Combo 1	Combines ECMs 1c,2b,3,5	\$50,300
ECM 4	Desiccant Wheel	\$40,000
ECM 6	Increase Thermostat Deadband	\$7,000
ECM 7	Install Free Cooling System	\$55,000

Total Savings (interactions accounted for): \$152,300

Table 3: Energy Conservation Predicted Results

Table 3 indicates the percent savings for *<insert the building/project name>* versus a similar building constructed to exactly meet energy code requirements. The estimated annual energy cost for the building without the recommended ECMs is presented first; the energy cost for the same building with the recommended ECMs implemented is presented second. The requirement of U-M Design Guidelines Special Instructions to Designers SID-D is for designs to provide buildings that cost 30% less to operate versus buildings designed to exactly meet the energy code.

Table 3: Energy Conservation Predicted Results¹

Estimated Energy Costs w/o ECMs ²	Dollars/Year
ASHRAE Base Building	\$420,000
Elevators	\$15,000
Process Cooling	\$12,000
Outdoor Lights	\$4,200
Total Energy Cost w/o ECMs:	\$451,200

Estimated Annual Energy Cost Avoidance w/ECMs: \$152,300

Estimated Percentage Cost Avoidance: 34%

Total Estimated First Cost of ECMs: \$1,210,000

Over-all Simple Payback (years): 7.9

Note 1: Compared to a baseline ASHRAE building using ASHRAE 90.1 Appendix G methodology. Actual energy use and savings may vary due to occupancy levels, occupancy schedules, utility rates, and other factors different than assumed in the analysis.

Note 2: Energy use break-down reported per ASHRAE 90.1 Appendix G requirements.

Table 4 provides a breakdown of ECM savings reported in energy units, useful for Utility incentive programs.

Table 4: Estimated Annual Savings in Energy Units, per ECM

Table 4 reports the estimated savings in energy units, with ECM interactions taken into account. Where combinations of ECMs are listed, it indicates that those ECMs interact with one another and therefore had to be analyzed as a group.

Table 4: Estimated Annual Savings in Energy Units, per ECM

ECM No.	Description	KWH/Year Savings	Therms/Year Savings
Combo 1	Combines ECMs 1c,2b,3,5		
ECM 4	Desiccant Wheel		
ECM 6	Increase Thermostat Deadband		
ECM 7	Install Free Cooling System		

Total:

Table 5: Water Conservation Measures and Predicted Results

Table 5 indicates the water saving measures and resulting percent water savings predicted for this project versus a project constructed to meet building code requirements (building code requirements are based on Energy Policy Act of 1992 fixture performance dictates). The requirement of U-M Design Guidelines Special Instructions to Designers SID-D is for designs to provide projects that use 20% less water than projects designed to exactly meet the building code.

Table 5: Water Conservation

Water Conservation Measure	Estimated Annual Savings (Gallons)
Dual Flush Water Closets	7,000
Waterless or 1/8 Gallon Per Flush Urinals	5,000
HVAC Condensate Used For Cooling Tower Make-Up	8,000
2 GPM Shower Heads	12,000
Gray Water Recovery	9,000

Estimated Total Annual Water Savings: 41,000

Annual Water use w/o Water Conservation Measures: 200,000

Estimated Percentage Savings: 21%

Table 6: Summary of ECM Evaluations

Table 6 summarizes every ECM evaluated by the design team for this particular project, along with various ECM financial metrics. For a detailed description and analysis of individual ECMs, please see the Appendices.

Include a detailed description and analysis of all evaluated ECMs, accepted and not accepted, in Appendix B.

Table 6: Summary of ECM Evaluated

ECM No.	Description	First Cost Estimate	Annual Costs Savings	Simple Payback	ROI	Persistence ¹ H/M/L	Accepted Yes/No	Comments
1a	Additional 0.75" Wall Insulation	\$180,000	\$14,000	12.9	7.8%	H	N	SD design/estimate included insulation 1" thicker than required by code.
1b	Additional 1" Wall Insulation	\$300,000	\$16,500	18.2	5.5%	H	N	
1c	Additional 1.5" Wall Insulation	\$350,000	\$18,400	19.0	5.3%	H	Y	
2a	Glass SHGC =0.38	\$186,000	\$7,500	24.8	4.0%	M	N	
2b	Glass SHGC =0.33	\$190,000	\$8,000	23.8	4.2%	M	Y	
2c	Argon Filled Triple Glazed Glass SHGC = 0.26	\$265,000	\$13,400	19.8	5.1%	L	N	Seal life guaranteed only 10 years. Slight gray tint.
3	Day Lighting Sensors, Atrium	\$42,000	\$12,000	3.5	28.6%	M	Y	
4	Desiccant Wheel	\$200,000	\$40,000	5.0	20.0%	M	Y	
5	Exterior Shades, South Facade	\$78,000	\$15,000	5.2	19.2%	H	Y	
6	Increase Thermostat Deadband	\$0	\$7,000	N/A	N/A	L	Y	
7	Free Cooling Process Load	\$350,000	\$55,000	6.4	15.7%	H	Y	
8	Shower Heat Recovery Device	\$24,000	\$3,000	8.0	12.5%	L	N	Maintenance issues

Note 1: Persistence represents an opinion of the probability that the estimated energy savings will be fully realized.

Useful Information:

KWH: Kilowatt Hours

MBTU: Thousands of British Thermal Units

Therms x 100 = MBTU

KWH x 3.413 = MBTU

Appendix A

Table A1: Energy Cost Assumptions:

Table A1 reports the energy cost assumptions utilized for energy cost calculations.

Table A1: Energy Costs Assumptions

Energy Type	Cost	Comments
Electricity	\$0.079 /kwh	DTE Direct Purchase Rate
Natural Gas	\$0.842/therm	MichiCon Direct Purchase Rate
District Steam	\$1.90/therm	U-M Utility Rate
District Chilled Water	\$1.07/therm	U-M Utility Rate

Table A2: Accepted ECMs (no ECM interactions) Additional Information

Table A2 presents the estimated annual cost and energy savings, and the relative contribution each ECM contributed toward total savings. Electrical and gas savings for each ECM have been converted to energy units of MBTU and combined.

Table A2: Accepted ECMs (no ECM interactions) Additional Information

ECM No.	Description	Dollars/Yr Savings	% of Total \$ Savings	MBTU/Yr Savings	% of Total MBTU Savings	First Cost
1c	Increase Wall Insulation to 2.75"	\$18,400	11.8%	450	16.8%	\$350,000
2b	Improved Window Performance, SHGC = 0.33, U = 0.44	\$8,000	5.1%	183	6.8%	\$190,000
3	Day Lighting Sensors, Atrium	\$12,000	7.7%	350	13.1%	\$42,000
4	Desiccant Wheel	\$40,000	25.7%	600	22.4%	\$200,000
5	Exterior Shades, South Façade	\$15,000	9.7%	224	8.4%	\$78,000
6	Increase Stat Deadband	\$7,000	4.5%	170	6.4%	\$0
7	Install Free Cooling System	\$55,000	35.4%	700	26.1%	\$350,000

Total First Cost:

\$1,210,000

Total Cost Savings: \$155,400

Total Energy Savings:

2,677

Tables A3 and A4:

U-M Design Guidelines Special Instructions to Designers SID-D requires that all projects implement certain "mandatory" energy conservation measures, and it requires that other energy conservation measures be "evaluated" for every project. Tables A3 and A4 indicate which of the mandatory and evaluated measures were found applicable to the project.

Table A3: Review of Mandatory Energy Conservation Measures

Mandatory ECM No.	Description	Implemented Yes/No	Comments	ECM Cross Ref.
a	Window Blinds/Shades	Y		ECM 9
b	Occupancy Schedules	Y		
c	Part Load Efficiency	Y		
d	HVAC System Zoning	Y		ECM 8
e	DDC VAV Control	Y		
f	Standalone HVAC Systems	N	No process areas.	
g	Laboratory ECMs	N	Not a lab building.	
h	Building Envelope Thermal Scanning	Y		ECM 4
i	Limit Incandescent Lighting	Y		
j	Lighting and Power Justification	N		

Table A4: Review of Mandatory Energy Evaluations

Mandatory Eval. No.	Description	Implemented Yes/No	Comments	ECM Cross Ref.
a	Additional Below-Grade Insulation			
b	Additional Wall Insulation			
c	Additional Roof Insulation			
d	Improved Glazing (1)			
e	Eliminate Server Rooms			
f	High Efficiency Chiller (1)			
g	Free Cooling			
h	Heat Recovery			
i	Increased Envelope Inspections			
j	Occupancy/Daylight Sensing			
k	High Efficiency Boiler (1)			
l	High Efficiency HVAC Equipment (1)			
m	Variable Volume Kitchen Hoods			

Note 1: Performance/efficiency better than required by code.

Appendix B

Detailed ECM descriptions and analysis:

Provide a detailed description and evaluation for each ECM considered. Each evaluation shall include the summary table indicated below, located at the beginning of the ECM and describe the proposed vs. the ASHRAE baseline. Number similar ECMs -a,-b,-c etc. as per the example.

ECM No.	Description	First Cost Estimate	Dollars/Year Savings	Simple Payback	MBTU/Year Savings
1a	Additional 0.75" Polystyrene Wall Insulation	\$180,000	\$14,000	12.9	
1b	Additional 1" Polystyrene Wall Insulation	\$300,000	\$16,500	18.2	
1c	Additional 1.5" Polystyrene Wall Insulation	\$350,000	\$18,400	19.0	

Description:

The base building wall insulation requirement,
Per ASHRAE 90.7 2007 =

$$R = 11.9 \text{ hr-ft}^2\text{-F/Btu}$$

$$U \text{ value} = 0.084 \text{ Btu}/(\text{hr-ft}^2\text{-F})$$

This ECM would increase the insulation
thickness as follows:

Increase 1.25" thick insulation to 2.0" Thick

$$R = 15.87 \text{ hr-ft}^2\text{-F/Btu}$$

$$U \text{ value} = 0.063 \text{ Btu}/(\text{hr-ft}^2\text{-F})$$

Increase 1.25" thick insulation to 2.25" Thick

$$R = 17.2 \text{ hr-ft}^2\text{-F/Btu}$$

$$U \text{ value} = 0.058 \text{ Btu}/(\text{hr-ft}^2\text{-F})$$

Increase 1.25" thick insulation to 2.75" Thick

$$R = 19.9 \text{ hr-ft}^2\text{-F/Btu}$$

$$U \text{ value} = 0.050 \text{ Btu}/(\text{hr-ft}^2\text{-F})$$

Construction Costs:

Describe the basis of the first cost estimate.

Appendix C:

Include the following in report Appendix C (in the order indicated):

- *Energy Impact Statement.*
- *A breakdown of energy usage by at least the following components: lights, internal equipment loads, service water heating equipment, space heating equipment, space cooling and heat rejection equipment, fans, and other HVAC equipment (such as pumps)*
- *Completed COMcheck compliance report demonstrating compliance to the mandatory provisions of ASHRAE Standard 90.1.*
- *Complete input data files and output reports from the energy simulation program. Include the name of the simulation program(s) used. The output reports shall also show the amount of time any loads are not met by the HVAC system for the baseline building design and the proposed building design. The proposed building design shall not have more “unmet hours” than the baseline building.*
- *An explanation of any error messages noted in the simulation program output.*

ENERGY IMPACT STATEMENT

For all projects with a construction budget over \$10 million, complete an Energy Impact Statement as required by the Design Guidelines SID-B, SID-D and the Design Deliverables. Refine and update the Energy Impact Statement throughout the three design phases as more detailed information regarding the project becomes available. For comparison, prior estimates are to be shown on subsequent updates of the Energy Impact Statement.

The following describes the general methodology to be used for each utility section. Provide supporting information with the Energy Impact Statement for each phase where required.

Legend:

- ALL: Requirement for each phase
- SD: Schematic Design Phase
- DD: Design Development Phase
- CD: Construction Document Phase

Electrical:

- ALL: Describe methods and assumptions used to calculate electrical estimates.
- SD: Can use watts per square foot.
Identify any unusual loads.
Estimates can be developed using a computer simulation or a spread sheet listing peak demand, estimated diversity and annual consumption.
- DD & CD: Estimates based on actual design and not watts per square foot.
Estimates can be developed using a computer simulation program or a spread sheet listing peak demand, estimated diversity and annual consumption.
Indicate diversity assumptions or include schedules from computer simulation.

Low Pressure Steam:

- ALL: Describe methods and assumptions used to calculate low pressure steam estimates.
Provide list of significant loads showing peak demand and annual consumption.
- SD: Heating consumption estimate can be developed using ASHRAE Degree Day Formula or Bin Estimate Method.
- CD & DD: Develop heating consumption estimates using a computer simulation program utilizing 8,760 hours per year analysis such as Trane Trace, Carrier HAP or Elite EZDOE.

60 PSI Steam:

- ALL: Describe methods and assumptions used to calculate 60 PSI steam estimates.
Provide list of significant loads showing peak demand and annual consumption.

Chilled Water:

- ALL: Describe methods and assumptions used to calculate chilled water estimates.
Provide list of significant loads showing peak demand and annual consumption.
- CD & DD: Develop chilled water cooling estimates using a computer simulation program utilizing 8,760 hours per year analysis such as Trane Trace, Carrier HAP or Elite EZDOE.

Domestic Cold Water:

- ALL: Describe methods and assumptions used to calculate domestic cold water estimates.
Provide fixture count summary and site source for estimating peak diversified demand.

Domestic Hot Water:

- ALL: Describe methods and assumptions used to calculate domestic hot water estimates.
Provide fixture count summary and site source for estimating peak diversified demand.

Natural Gas:

- ALL: Describe methods and assumptions used to calculate natural gas estimates.

Storm Drainage system:

- ALL: Describe methods and assumptions used to calculate storm drainage estimates.

Building Description and Assumptions:

Provide a brief narrative describing various building related items and assumptions used to complete the Energy Impact Statement. Among these are the following:

- a. Building Gross Floor Area
- b. Building Hours of Operation (breakdown for various key areas as required)
- c. Utilities Required
- d. Mechanical Systems Description
- e. Chilled Water Design Entering and Leaving Temperatures
- f. Assumed Design Residual Pressure for the Domestic Cold Water System
- g. Electrical System Description

ENERGY IMPACT STATEMENT BLANK FORM

Project Name: <insert project name> U of M Project No.: <insert project number>

	Schematic Phase	Design Development Phase	Construction Document Phase
Building Energy Summary:			
Project Affected Gross Area, (GSF)			
Annual Building Energy Consumption All Energy Input Converted to BTU, (MBTU/year)			
Annual Building Energy Consumption per GSF, (BTU/year/GSF)			

Electrical:

Maximum Demand, (kW)			
Annual Consumption, (kWH/year):			
Lighting	<i>Not Required</i>		
Miscellaneous Power	<i>Not Required</i>		
HVAC Equipment	<i>Not Required</i>		

Low Pressure Steam:

Peak Load, (lbs/hr):			
Summer			
Winter			
Annual Consumption, (MLB/yr):			
Heating	<i>Not Required</i>		
Humidification	<i>Not Required</i>		
Air Conditioning	<i>Not Required</i>		
Domestic Water Heating	<i>Not Required</i>		
Process	<i>Not Required</i>		

60 PSI Steam:

Peak Load, (lbs/hr):			
Summer			
Winter			
Annual Consumption, (MLB/yr)			

Project Name: <insert project name> U of M Project No.: <insert project number>

	Schematic Phase	Design Development Phase	Construction Document Phase
Chilled Water:			
Peak Load, (tons/hour):			
Summer			
Winter			
Annual Consumption, (ton-hours/year)			

Domestic Cold Water:			
Peak Cold Water Demand, (GPM)			
Peak Sanitary Demand, (GPM)			
Annual Consumption, (million gallons/year):			
Sanitary Sewer	<i>Not Required</i>		
Cooling Tower Evaporation	<i>Not Required</i>		
Cooling Tower Blowdown	<i>Not Required</i>		

Domestic Hot Water:			
Peak Demand, (GPM)			
Annual Consumption, (million gallons/year)			

Natural Gas:			
Peak Demand, (CCF/hour)			
Annual Consumption, (CCF/year)			

Storm Drainage system:			
Design Storm Peak Volume, (GPM)			

ENERGY IMPACT STATEMENT

SAMPLE

Building Description and Assumptions:

General:

- Central Campus building with mix of offices and classrooms. Some small labs.

Building Gross Floor Area:

- 40,000 GSF (4 Stories @ 10,000 GSF each)

Building Hours of Operation (breakdown for various key areas as required):

- 7 a.m. – 6 p.m. and as further defined in the attached calculations and computer simulation input schedules.

Utilities Required:

- Low pressure steam from Central Power Plant.
- High pressure steam from Central Power Plant.
- Domestic hot water from Central Power Plant.
- Domestic cold water from City of Ann Arbor.
- Natural gas from MichCon.
- Electricity from Central Campus sub-station.

Mechanical Systems Description:

- Single low pressure steam absorption water chiller.
- Roof mounted cooling tower.
- Two air handling units located in the basement mechanical room.
- VAV boxes with hot water reheat coils.
- Hot water perimeter heating via steam/hot water heat exchanger.
- Gas fired unit heaters at Loading Dock.
- High pressure steam for autoclaves.
- 44 F Entering Chilled Water Temperature, 56 F Leaving Chilled Water Temperature.
- Assumed design residual pressure for the Domestic Cold Water System is 30 psi.

Electrical System Description

- Electrical feed will come from Central Campus feeder 21-2.
- No emergency generator is required.

Project Name: XXXXXX Addition & Renovation U of M Project No.: Project No. P0000XXXX

Building Energy Summary:	Schematic Phase	Design Development Phase	Construction Document Phase
Project Affected Gross Area, (GSF)	40,000 (See Exhibit A, 1.1)	40,000 (See Exhibit B, 1.1)	40,000 (See Exhibit C)
Annual Building Energy Consumption All Energy Input Converted to BTU, (MBTU/year)	14,518 (See Exhibit A, 1.2)	12,781 (See Exhibit B, 1.2)	12,781 (See Exhibit C)
Annual Building Energy Consumption per GSF, (BTU/year/GSF)	363,000 (See Exhibit A, 1.3)	319,500 (See Exhibit B, 1.3)	319,500 (See Exhibit C)

Electrical:

Maximum Demand, (kW)	480 (See Exhibit A, 2.1)	474 (See Exhibit B, 2.1)	474 (See Exhibit C)
Annual Consumption, (kWH/year):	800,000 (See Exhibit A, 2.2)	786,545 (See Exhibit B, 2.2)	786,545 (See Exhibit C)
Lighting	Not Required	346,080 (See Exhibit B, 2.3)	346,080 (See Exhibit C)
Miscellaneous Power	Not Required	212,367 (See Exhibit B, 2.4)	212,367 (See Exhibit C)
HVAC Equipment	Not Required	228,098 (See Exhibit B, 2.5)	228,098 (See Exhibit C)

Low Pressure Steam:

Peak Load, (lbs/hr):			
Summer	6,400 (See Exhibit A, 3.1)	6,080 (See Exhibit B, 3.1)	6,080 (See Exhibit C)
Winter	1,552 (See Exhibit A, 3.2)	1,403 (See Exhibit B, 3.2)	1,403 (See Exhibit C)
Annual Consumption, (MLB/yr):	9,743 (See Exhibit A, 3.3)	8,404 (See Exhibit B, 3.3)	8,404 (See Exhibit C)
Heating	Not Required	2,436 (See Exhibit B, 3.4)	2,436 (See Exhibit C)
Humidification	Not Required	9 (See Exhibit B, 3.5)	9 (See Exhibit C)
Air Conditioning	Not Required	5,957 (See Exhibit B, 3.6)	5,957 (See Exhibit C)
Domestic Water Heating	Not Required	2 (See Exhibit B, 3.7)	2 (See Exhibit C)
Process	Not Required	0 (See Exhibit B, 3.8)	0 (See Exhibit C)

60 PSI Steam:

Peak Load, (lbs/hr):			
Summer	400 (See Exhibit A, 4.1)	250 (See Exhibit B, 4.1)	250 (See Exhibit C)
Winter	400 (See Exhibit A, 4.2)	250 (See Exhibit B, 4.2)	250 (See Exhibit C)
Annual Consumption, (MLB/yr)	200 (See Exhibit A, 4.3)	125 (See Exhibit B, 4.3)	125 (See Exhibit C)

	Schematic Phase	Design Development Phase	Construction Document Phase
Chilled Water:			
Peak Load, (tons/hour):			
Summer	320 (See Exhibit A, 5.1)	304 (See Exhibit B, 5.1)	304 (See Exhibit C)
Winter	100 (See Exhibit A, 5.2)	82 (See Exhibit B, 5.2)	82 (See Exhibit C)
Annual Consumption, (ton-hours/year)	320,000 (See Exhibit A, 5.3)	297,856 (See Exhibit B, 5.3)	297,856 (See Exhibit C)

Domestic Cold Water:

Peak Cold Water Demand, (GPM)	200 (See Exhibit A, 6.1)	200 (See Exhibit B, 6.1)	200 (See Exhibit C)
Peak Sanitary Demand, (GPM)	231 (See Exhibit A, 6.2)	231 (See Exhibit B, 6.2)	231 (See Exhibit C)
Annual Consumption, (million gallons/year):	9.53 (See Exhibit A, 6.4)	9.53 (See Exhibit B, 6.3)	9.53 (See Exhibit C)
Sanitary Sewer	Not Required	11.53 (See Exhibit B, 6.4)	11.53 (See Exhibit C)
Cooling Tower Evaporation	Not Required	2.04 (See Exhibit B, 6.5)	2.04 (See Exhibit C)
Cooling Tower Blowdown	Not Required	0.37 (See Exhibit B, 6.6)	0.37 (See Exhibit C)

Domestic Hot Water:

Peak Demand, (GPM)	75 (See Exhibit A, 7.1)	75 (See Exhibit B, 7.1)	75 (See Exhibit C)
Annual Consumption, (million gallons/year)	3.01 (See Exhibit A, 7.2)	3.01 (See Exhibit B, 7.2)	3.01 (See Exhibit C)

Natural Gas:

Peak Demand, (CCF/hour)	5 (See Exhibit A, 8.1)	4 (See Exhibit B, 8.1)	4 (See Exhibit C)
Annual Consumption, (CCF/year)	2,500 (See Exhibit A, 8.2)	2,000 (See Exhibit B, 8.2)	2,000 (See Exhibit C)

Storm Drainage system:

Design Storm Peak Volume, (GPM)	286 (See Exhibit A, 9.1)	302 (See Exhibit B, 9.1)	302 (See Exhibit C)
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ENERGY IMPACT STATEMENT

SAMPLE EXHIBIT A - SCHEMATIC DESIGN PHASE CALCULATIONS

In accordance with the Design Phase Deliverables; at the Schematic Design Phase, complete the following items which contribute to the development of the Energy Impact Statement:

- *Reviewed energy code requirements.*
- *Typical building elevations with window placement .*
- *Roof layout.*
- *Typical floor plans with identified area uses and resulting area square footage.*
- *Identified all needed HVAC systems with one-line flow diagrams.*
- *Conceptual plumbing and piping layout.*
- *Electric one-line diagrams based on conceptual electric requirements.*

Item No.	Building Energy Summary	Descriptions & Calculations
1.1	Project Affected Gross Area, (GSF)	40,000 Sq. Ft. per Schematic Design Phase Space Programming.
1.2	Annual Building Energy Consumption, (MBTU/year)	All Energy Input Converted to MBTU/year Electric = 2,730.4 MBTU/year [See Item 2.2] Low Pressure Steam = 11,301.0 MBTU/year [See Item 3.3] 60 PSI Steam = 236.4 MBTU/year [See Item 4.3] <u>Natural Gas = 250.0 MBTU/year [See Item 8.2]</u> Total All Sources = 14,519 MBTU/year
1.3	Annual Building Energy Consumption per Sq. Ft., (BTU/year/GSF)	14,519 MBTU/year / 40,000 SF = 363,000 Btu/year/SF

Item No.	Electrical	Descriptions & Calculations
2.1	Maximum Demand, (kW)	Assume: Lighting @ 2 Watts/SF Misc. Electric @ 5 Watts/SF HVAC @ 5 Watts/SF Results in 480 kW Peak Summer Load
2.2	Annual Consumption, (MWH/year)	Assume Annual consumption @ 20 kWh/year per SF. 20 kWh/year per SF X 40,000 SF = 800,000 kWh/year.
2.3	Lighting	<i>Breakout value not required for this item in Schematic Phase.</i>
2.4	Miscellaneous Power	<i>Breakout value not required for this item in Schematic Phase.</i>
2.5	HVAC Equipment	<i>Breakout value not required for this item in Schematic Phase.</i>

Item No.	Low Pressure Steam	Descriptions & Calculations
3.1	Summer Peak Load, (lbs/hr)	Cooling load assumed to be 125 SF/ton @ 40,000 SF = 320 tons/hr. Steam consumption for absorption chillers is approximately 20 lb/hr at 9 psi. Therefore, 320 tons X 20 lbs/hr = 6,400 lbs/hr.
3.2	Winter Peak Load, (lbs/hr)	Heating load assumed to be 45 Btu/SF X 40,000 SF Gross Floor Area /1160 BTU per lb @ 9 psi = 1,552 lbs/hr.
3.3	Annual Consumption, (MLB/yr)	<p>Cooling Consumption = 320,000 ton-hours/year [see Chilled Water, Item 4.3] X 20 lb-hour / 1000 lbs per MLB = 6,400 MLB/year.</p> <p>Heating Consumption = Using Heating Degree Day Method: $((1,552 \text{ lbs/hr peak load} / (-10^\circ\text{F} - 72^\circ\text{F})) \times 6,258 \text{ Heating Degree Days [from ASHRAE 1984 Fundamentals, pg 24.25]} \times 24) / 1000 \text{ lbs per MLB} = 2,843 \text{ MLB/year.}$</p> <p>Humidification + Domestic Water Re-Heating + Miscellaneous Steam Loads is assumed to be 500 MLB/year.</p> <p>Total Annual Consumption = Cooling + Heating + Miscellaneous = 6,400 + 2843 + 500 = 9,743 MLB/year.</p>
3.4	Heating	<i>Breakout value not required for this item in Schematic Phase.</i>
3.5	Humidification	<i>Breakout value not required for this item in Schematic Phase.</i>
3.6	Air Conditioning	<i>Breakout value not required for this item in Schematic Phase.</i>
3.7	Domestic Water Heating	<i>Breakout value not required for this item in Schematic Phase.</i>
3.8	Process	<i>Breakout value not required for this item in Schematic Phase.</i>

Item No.	60 PSI Steam	Descriptions & Calculations
4.1	Summer Peak Load, (lbs/hr)	Four Autoclaves: Assume 4 X 100 lbs/hour of 60 PSI steam required = 400 lbs/hour.
4.2	Winter Peak Load, (lbs/hr)	Same as Summer Peak Load = 400 lb/hr.
4.3	Annual Consumption, (MLB/yr)	Four Autoclaves: Assume 4 X 100 lbs/hour of 60 PSI steam required / 1000 lbs/hour per MLB/hr X 2 cycles/day X 250 days/yr = 200 MLB/year

Item No.	Chilled Water	Descriptions & Calculations
5.1	Summer Peak Load, (tons/hour)	Cooling load assumed to be 125 SF/ton @ 40,000 SF = 320 tons/hr.
5.2	Winter Peak Load, (tons/hour)	Assume winter peak load for computer server rooms and miscellaneous year-round cooling needs at 100 tons.
5.3	Annual Consumption, (ton-hours/year)	<p>Using Equivalent Full Load Hours Method: 320 tons peak load X 1000 hours equivalent full load operation [from ASHRAE 1984 Fundamentals, pg 28.5] = 320,000 ton-hours/year.</p> <p>Using Cooling Degree Day Method: (320 tons peak load/92 °F - 72 °F) X 687 Cooling Degree Days [from ASHRAE 1984 Fundamentals, pg 28.6] X 24 = 219,840 ton-hours/year.</p> <p>Conclusion: Use 320,000 ton-hours/year.</p> <p>Note: winter cooling load is handled by winterized cooling towers via free cooling system.</p>

Item No.	Domestic Cold Water	Descriptions & Calculations
6.1	Peak Demand, (GPM)	<p>Based on a review of the International Building Code, 2000 and International Plumbing Code, 2000 to determine maximum building occupancy levels and resulting minimum number of plumbing facilities, as well as a review of similar building types on campus, it was determined that the domestic cold water peak demand be based on 750 fixture units.</p> <p>From Table E102 of the International Plumbing Code, 2000, the resulting domestic cold water peak demand is 177 GPM.</p> <p>Additionally the cooling tower has an estimated peak domestic cold water demand of 23 GPM [Calculated using “Marley Cooling Tower Fundamentals”].</p> <p>Total DCW Peak Demand = $177 + 23 = 200$ GPM.</p>
6.2	Peak Sanitary Demand, (GPM)	<p>Peak Sanitary Demand = Domestic Cold Water Demand [Item 5.1] + Domestic Hot Water Demand [Item 6.1] – Cooling Tower Make-up [Item 5.1] = $177 + 77 - 23 = 231$ GPM.</p>
6.3	Annual Consumption, (gallons/year):	<p>Occupied DCW: $177 \text{ GPM} \times 25\% \text{ Diversity} \times 2,000 \text{ hours/year} = 5.31 \text{ million gallons/year.}$</p> <p>Unoccupied DCW: $177 \text{ GPM} \times 2.5\% \text{ Diversity} \times 6,760 \text{ hours/year} = 1.80 \text{ million gallons/year.}$</p> <p>Cooling Tower Make-up: $23 \text{ GPM} \times 20\% \text{ Diversity} \times 8,760 \text{ hours/year} = 2.42 \text{ million gallons/year.}$</p> <p>Total = $5.31 + 1.80 + 2.42 = 9.53$ million gallons/year.</p>
6.4	Sanitary Sewer	<i>Breakout value not required for this item in Schematic Phase.</i>
6.5	Cooling Tower Evaporation + Drift	<i>Breakout value not required for this item in Schematic Phase.</i>
6.6	Cooling Tower Blowdown	<i>Breakout value not required for this item in Schematic Phase.</i>

Item No.	Domestic Hot Water	Descriptions & Calculations
7.1	Peak Demand, (GPM)	Based on a review of the International Building Code, 2000 and International Plumbing Code, 2000 to determine maximum building occupancy levels and resulting minimum number of plumbing facilities, as well as a review of similar building types on campus, it was determined that the domestic hot water peak demand be based on 250 fixture units. From Table E102 of the International Plumbing Code, 2000, the resulting domestic hot water peak demand is 75 GPM.
7.2	Annual Consumption, (million gallons/year):	Occupied: 75 GPM X 25% Diversity X 2,000 hours/year = 2.25 million gallons/year. Unoccupied: 75 GPM X 2.5% Diversity X 6,760 hours/year = 0.76 million gallons/year. Total = 2.25 + 0.76 = 3.01 million gallons/year.

Item No.	Natural Gas	Descriptions & Calculations
8.1	Peak Demand, (CCF/hour)	Two Gas Fired Unit Heaters in Loading Dock: Assume 2 X 250,000 BTU/hr = 500,000 BTU/hr / 100,000 BTU/CCF = 5 CCF/hour.
8.2	Annual Consumption, (CCF/year):	Two Gas Fired Unit Heaters in Loading Dock: Assume 2 X 250,000 BTU/hr X 2000 hours/year operation x 25% diversity / 100,000 BTU/CCF = 2,500 CCF/year.

Item No.	Storm Drainage System	Descriptions & Calculations
9.1	Design Peak Storm Volume, (GPM)	From 2000 International Plumbing Code, Section 1106: Assume roof area of 10,000 sf @ 2.75 inches/hr (100 year rainfall) = 286 GPM.

ENERGY IMPACT STATEMENT

SAMPLE EXHIBIT B - DESIGN DEVELOPMENT PHASE CALCULATIONS

In accordance with the Design Phase Deliverables; at the Design Development Phase, complete the following items (in addition to those completed during the Schematic Design Phase) which contribute to the further refinement of the Energy Impact Statement:

- *All building elevations with window placement and wall sections .*
- *Roof and drainage plan.*
- *All floor plans with identified area uses and resulting area square footage.*
- *Design criteria for each mechanical system.*
- *Equipment schedules for major mechanical items.*
- *Overall building airflow diagram.*
- *Conceptual control diagrams for all mechanical and plumbing systems.*
- *Preliminary calculations for HVAC systems.*
- *Design criteria for each plumbing system, including set points, etc.*
- *One-line diagrams for all plumbing systems.*
- *Plumbing and piping plans.*
- *Typical lighting plans.*
- *Lighting fixture schedule.*
- *Review of lighting energy code requirements.*
- *Normal power riser diagram.*
- *Power panel schedules.*
- *Electric load estimates.*

Item No.	Building Energy Summary	Descriptions & Calculations
1.1	Project Affected Gross Area, (GSF)	40,000 GSF per Design Development Phase Space Programming.
1.2	Annual Building Energy Consumption, (MBTU/year)	All Energy Input Converted to MBTU/year Electric = 2,684 MBTU/year [See Item 2.2] Low Pressure Steam = 9,749 MBTU/year [See Item 3.3] 60 PSI Steam = 148 MBTU/year [See Item 4.3] <u>Natural Gas = 200 MBTU/year [See Item 8.2]</u> Total All Sources = 12,781 MBTU/year
1.3	Annual Building Energy Consumption per GSF, (BTU/year/GSF)	12,781 MBTU/year / 40,000 GSF = 319,522 kBtu/year/GSF

Item No.	Electrical	Descriptions & Calculations
2.1	Maximum Demand, (kW)	<p>Data from Design Development Phase lighting and power panel schedules was input into a computer simulation program. See Table B.1, “Billing Details – Electric” for maximum electric demand.</p> <p>The maximum electric demand of 474 kW occurs in June.</p>
2.2	Annual Consumption, (MWH/year)	<p>Data from Design Development Phase lighting and power panel schedules was input into a computer simulation program. See Table B.1, “Billing Details – Electric” for annual electric consumption.</p> <p>The annual electric consumption for all components is 786,545 kWh.</p>
2.3	Lighting	<p>For electrical consumption by component, see Table B.2, “Energy Budget by System Component”. This table shows electrical energy as kBTUs. The estimated annual electrical consumption for lighting is listed under “Site Energy” as 1,181,170 kBTU per year. This converts to 346,080 kWh per year.</p>
2.4	Miscellaneous Power	<p>For electrical consumption by component, see Table B.2, “Energy Budget by System Component”. This table shows electrical energy as kBTUs. The estimated annual electrical consumption for miscellaneous power is listed under “Site Energy” as 724,809. This converts to 212,367 kWh per year.</p>
2.5	HVAC Equipment	<p>For electrical consumption by component, see Table B.2, “Energy Budget by System Component”. This table shows electrical energy as kBTUs. The estimated annual electrical consumption for HVAC is listed under “Site Energy” as the sum of the air system fans, pumps and cooling towers, or $536,896 + 53,690 + 187,913 = 778,499$. This sum converts to 228,098 kWh per year.</p>

Item No.	Low Pressure Steam	Descriptions & Calculations
3.1	Summer Peak Load, (lbs/hr)	<p>Data from Design Development Phase was input into a computer simulation program to determine the estimated summer peak steam demand. See Table B.3, “Hourly Simulation – Summer Chiller Plant” for details. The peak summer steam demand includes steam for the absorption chiller.</p> <p>The peak summer steam demand of 6,080 lbs/hr occurs at 4:00 pm on July 22.</p>
3.2	Winter Peak Load, (lbs/hr)	<p>Data from Design Development Phase was input into a computer simulation program to determine the estimated winter peak steam demand. See Table B.5, “Hourly Simulation – Heating Plant” for details. The peak winter steam demand includes all heating loads plus humidification loads.</p> <p>The peak winter steam demand of 1,628 MBH or 1,403 lbs/hr occurs at 7:00 am on January 15.</p>
3.3	Annual Consumption, (MLB/yr)	<p>Total Annual Consumption = Heating [Item 3.4] + Humidification [Item 3.5] + Air Conditioning [Item 3.6] + Domestic Water Reheating [Item 3.7] = 2,436 + 8.94 + 5,957 + 2 = 8,404 MLB/year.</p>
3.4	Heating	<p>For steam consumption by component, see Table B.2, “Energy Budget by System Component”. This table shows steam energy as kBTUs. The estimated annual steam consumption for heating is listed under “Site Energy” as 2,825,760. This converts to 2,436 MLB per year.</p>
3.5	Humidification	<p>For steam consumption by component, see Table B.2, “Energy Budget by System Component”. This table shows steam energy as kBTUs. The estimated annual steam consumption for humidification is listed under “Site Energy” as 107,228. This converts to 8.94 MLB per year.</p>
3.6	Air Conditioning	<p>For steam consumption by component, see Table B.2, “Energy Budget by System Component”. This table shows steam energy as kBTUs. The estimated annual steam consumption for air conditioning (steam absorption) is listed under “Site Energy” as 6,910,259. This converts to 5,957 MLB per year.</p>
3.7	Domestic Water Heating	<p>Domestic hot water is supplied from the Central Power Plant. Supplemental reheating of the domestic hot water is done with Plant steam to maintain the discharge water temperature set point.</p> <p>The annual consumption is estimated at 2 MLB per year.</p>
3.8	Process	None required for this building

Item No.	60 PSI Steam	Descriptions & Calculations
4.1	Summer Peak Load, (lbs/hr)	<p>During the Design Development Phase two autoclaves were eliminated. From the equipment schedules, the two remaining autoclaves require 125 lbs/hour.</p> <p>2 X 125 lbs/hour of 60 PSI steam required = 250 lbs/hour.</p>
4.2	Winter Peak Load, (lbs/hr)	Same as Summer Peak Load = 250 lbs/hr.
4.3	Annual Consumption, (MLB/yr)	<p>Assume 2 X 125 lbs/hour of 60 PSI steam required / 1000 lbs/hour per MLB/hr X 2 cycles/day X 250 days/yr = 125 MLB/year</p>

Item No.	Chilled Water	Descriptions & Calculations
5.1	Summer Peak Load, (tons/hour)	<p>Data from Design Development Phase was input into a computer simulation program to determine the estimated peak chilled water demand. See Table B.3, “Hourly Simulation – Summer Chiller Plant ” for details.</p> <p>The peak summer chilled water demand of 3,648 MBH or 304 tons occurs at 4:00 pm on July 22.</p>
5.2	Winter Peak Load, (tons/hour)	<p>Data from Design Development Phase was input into a computer simulation program to determine the estimated peak chilled water demand. See Table B.4, “Hourly Simulation – Winter Chiller Plant” for details.</p> <p>Winter free cooling operation (absorption chillers off) is assumed to occur between October and April.</p> <p>The peak winter chilled water demand of 984 MBH or 82 tons occurs at 2:00 pm on April 28.</p>
5.3	Annual Consumption, (ton-hours/year)	<p>Data from Design Development Phase was input into a computer simulation program to determine the annual chilled water consumption. See Table B.2, “Energy Budget by System Component” for details.</p> <p>The estimated annual chilled water consumption is listed under “Site Energy” as 3,574,272 kBTU. This converts to 297,856 ton-hours per year.</p> <p>Note: winter cooling load is handled by winterized cooling towers via free cooling system.</p>

Item No.	Domestic Cold Water	Descriptions & Calculations
6.1	Peak Demand, (GPM)	<p>Based on a review of the International Building Code, 2000 and International Plumbing Code, 2000 to determine maximum building occupancy levels and resulting minimum number of plumbing facilities, as well as a review of similar building types on campus, it was determined that the domestic cold water peak demand be based on 750 fixture units.</p> <p>From Table E102 of the International Plumbing Code, 2000, the resulting domestic cold water peak demand is 177 GPM.</p> <p>Additionally the cooling tower has an estimated peak domestic cold water demand of 23 GPM [Calculated using “Marley Cooling Tower Fundamentals”].</p> <p>Total DCW Peak Demand = $177 + 23 = 200$ GPM.</p>
6.2	Peak Sanitary Demand, (GPM)	<p>Peak Sanitary Demand = Domestic Cold Water Demand [Item 5.1] + Domestic Hot Water Demand [Item 6.1] – Cooling Tower Make-up [Item 5.1] = $177 + 77 - 23 = 231$ GPM.</p>
6.3	Annual Consumption, (million gallons/year):	<p>Occupied DCW: $177 \text{ GPM} \times 25\% \text{ Diversity} \times 2,000 \text{ hours/year} = 5.31 \text{ million gallons/year}.$</p> <p>Unoccupied DCW: $177 \text{ GPM} \times 2.5\% \text{ Diversity} \times 6,760 \text{ hours/year} = 1.80 \text{ million gallons/year}.$</p> <p>Cooling Tower Make-up: $23 \text{ GPM} \times 20\% \text{ Diversity} \times 8,760 \text{ hours/year} = 2.42 \text{ million gallons/year}.$</p> <p>Total = $5.31 + 1.80 + 2.42 = 9.53$ million gallons/year.</p>
6.4	Annual Sanitary Sewer, (million gallons/year)	<p>Annual sanitary sewer volume is estimated as: The sum of the annual domestic cold water (DCW) consumption + annual domestic hot water (DHW) consumption + annual cooling tower blowdown.</p> <p>Occupied DCW = 5.31 million gallons/year. [Item 6.3] Unoccupied DCW = 1.80 million gallons/year. [Item 6.3] Occupied DHW = 2.25 million gallons/year. [Item 7.2] Unoccupied DHW = 0.76 million gallons/year. [Item 7.2] Cooling Tower Blowdown = 0.37 million gallons/year. [Item 6.6]</p> <p>Total = $5.31 + 1.80 + 2.25 + 1.80 + 0.37 = 11.53$ million gallons/year.</p>
6.5	Cooling Tower Evaporation + Drift, (million gallons/year):	<p>Peak cooling tower evaporation is calculated using “Marley Cooling Tower Fundamentals” as: $E = R/10/100 \times \text{Circulation Water Volume}$ Where: E=Evaporation, GPM R=Tower temperature range. In this case $100 \text{ F} - 85 \text{ F} = 15 \text{ F}.$ Circulation water volume is 4 GPM per ton of absorption chilling or $4 \text{ GPM} \times 320 \text{ Tons} = 1,280 \text{ gallons of circulating water}.$ $E = 15/10/100 \times 1,280 = 18.1 \text{ GPM}$</p> <p>Peak cooling tower drift is calculated as: $D = 0.1\% \times \text{Circulation Water Volume}$ $D = 0.1\% \times 1,280 = 1.3 \text{ GPM}$</p>

		<p>Annual cooling tower evaporation + drift is estimated as: $(18.1 \text{ GPM} + 1.3 \text{ GPM}) \times 20\% \text{ Diversity} \times 8,760 \text{ hours/year}$ $= 2.04 \text{ million gallons/year}$.</p> <p>Note: This water volume is not included in the sanitary sewer calculation as it does not go to the sanitary sewer.</p>
6.7	Cooling Tower Blowdown, (million gallons/year):	<p>Peak cooling tower blowdown is calculated using “Marley Cooling Tower Fundamentals” as: $B = (((R/10) / (CC-1)) - 0.1) / 100 \times \text{Circulating Water Volume}$ Where: B=Blowdown, GPM R=Tower temperature range. In this case $100 \text{ F} - 85 \text{ F} = 15 \text{ F}$. CC=Concentration cycles. In this case 5 cycles is assumed. Circulation water volume is 4 GPM per ton of absorption chilling or $4 \text{ GPM} \times 320 \text{ Tons} = 1,280 \text{ gallons of circulating water}$. $B = ((15/10) / (5-1)/100) \times 1,280 = 3.5 \text{ GPM}$</p> <p>Annual cooling tower blowdown is estimated as: $3.5 \text{ GPM} \times 20\% \text{ Diversity} \times 8,760 \text{ hours/year}$ $= 0.37 \text{ million gallons/year}$.</p> <p>Note: This water volume is included in the sanitary sewer calculation as it does go to the sanitary sewer.</p>

Item No.	Domestic Hot Water	Descriptions & Calculations
7.1	Peak Demand, (GPM)	<p>Based on a review of the International Building Code, 2000 and International Plumbing Code, 2000 to determine maximum building occupancy levels and resulting minimum number of plumbing facilities, as well as a review of similar building types on campus, it was determined that the domestic hot water peak demand be based on 250 fixture units.</p> <p>From Table E102 of the International Plumbing Code, 2000, the resulting domestic hot water peak demand is 75 GPM.</p>
7.2	Annual Consumption, (million gallons/year):	<p>Occupied: $75 \text{ GPM} \times 25\% \text{ Diversity} \times 2,000 \text{ hours/year}$ $= 2.25 \text{ million gallons/year}$.</p> <p>Unoccupied: $75 \text{ GPM} \times 2.5\% \text{ Diversity} \times 6,760 \text{ hours/year}$ $= 0.76 \text{ million gallons/year}$.</p> <p>Total = $2.25 + 0.76 = 3.01 \text{ million gallons/year}$.</p>

Item No.	Natural Gas	Descriptions & Calculations
8.1	Peak Demand, (CCF/hour)	Two Gas Fired Unit Heaters in Loading Dock: From the Design Development Phase mechanical equipment schedules, the two gas fired unit heaters were downsized two at 200,000 BTU/hr each. $2 \times 200,000 \text{ BTU/hr} = 400,000 \text{ BTU/hr} / 100,000 \text{ BTU/CCF} = 4 \text{ CCF/hour.}$
8.2	Annual Consumption, (CCF/year):	Two Gas Fired Unit Heaters in Loading Dock: Assume $2 \times 200,000 \text{ BTU/hr} \times 2000 \text{ hours/year operation} \times 25\% \text{ diversity} / 100,000 \text{ BTU/CCF} = 2,000 \text{ CCF/year.}$

Item No.	Storm Drainage System	Descriptions & Calculations
9.1	Design Peak Storm Volume, (GPM)	Roof area from Design Development Phase Roof Plan is 10,560 SF. From 2000 International Plumbing Code, Section 1106: $10,560 \text{ SF @ } 2.75 \text{ inches/hr (100 year rainfall)} = 302 \text{ GPM.}$

ENERGY IMPACT STATEMENT

SAMPLE EXHIBIT C - CONSTRUCTION DOCUMENT PHASE CALCULATIONS

In accordance with the Design Phase Deliverables; at the Construction Document Phase, complete the following items (in addition to those completed during the Design Development Phase) which contribute to the further refinement of the Energy Impact Statement:

- *Complete specification.*
- *One-line diagrams for all mechanical systems.*
- *Duct layout and air flow volumes for each space.*
- *Detailed control drawings with sequences of operation.*
- *All design calculations.*
- *Lighting plans for all areas.*
- *Electrical power load summary.*
- *Electrical panel schedules.*

Because the majority of the information needed for accurate estimates in the Energy Impact Statement is available in the Design Development Phase, most projects will require very little modification of the Energy Impact Statement in moving to the Construction Document Phase. Also, there is no change in the methodology used to determine estimates in moving from the Design Development Phase to the Construction Document Phase.

For these reasons, it is assumed that (for this example) there is no change in the Energy Impact Statement. Estimates shown in the Design Development Phase column of the Energy Impact Statement are repeated in the Construction Document Phase column.

It is not unusual for projects to change significantly in moving from Design Development Phase to Construction Document Phase (usually due to budget constraints). In these cases there may be significant changes to the Energy Impact Statement which the Design Professional will be expected to document.



SUBSTITUTIONS

(Formerly Owner's Option)

General

The University requires that specific vendor's products be used to assure job quality through reliability, ease of maintenance, manufacturers proven maintenance and warranty support, control of stock and value. This process is controlled by disallowing the Contractor from making substitutions for specified products. The Contractor is typically permitted to propose Owner's Options (voluntary alternates) at the time of bid only. It is unusual for the University to consider a substitution after bids have been awarded and during the construction phase.

Related Documents

[Project Manual](#), Instructions to Bidders

[Preferred Manufacturers List \(PML\)](#)

Specifications

Include language explicitly prohibiting substitutions.

Do not use the phrase "or equal" after any specific vendor's product identification in the specification sections or on the drawings (including details).

For all specification sections that are included in the PML, restrict product selections to those manufacturers listed in the PML. Where none are listed, select manufacturers utilizing the criteria in the "General" paragraph of this document. The University encourages the largest number of PML listed manufacturers be included in the specification. However, if there are concerns with a particular manufacturer, it is not required they be included, provided a minimum of three are listed as approved in the specification. If it is believed manufacturers other than those listed in the PML should be considered, discuss this issue with the Design Manager prior to release of the construction documents.

COMMISSIONING

Scope

Most projects, especially those with extensive mechanical and electrical systems, will undergo a U-M building commissioning (Cx) process. The U-M Cx process is described below. Become familiar with, fully participate in and fully support this process.

Related Documents

U-M Building Commissioning Documents:

[Full Project Commissioning](#)
[Project Commissioning for Small Projects](#)
[Generic Sample Commissioning Manual](#)
[Generic Sample Commissioning Forms](#)
[Commissioning Reports](#)

U-M Design Guidelines:

[SID-B - Design Intent Documents](#)
[SID-D – Energy and Water Conservation](#)
[SID-K – Sustainable Design and LEED® Requirements](#)
[SID-L – Owner’s Review](#)

U-M Master Specification Sections:

[01710 – Project Commissioning for Small Projects](#)
[01715 – Full Project Commissioning](#)
[01782 – Operation and Maintenance Manuals](#)

Reference Documents:

ASHRAE Guideline 0-2005, “The Commissioning Process”
Building Commissioning Association, "The Building Commissioning Handbook", 2nd Edition
USGBC, “LEED® Reference Guide for Green Building Design and Construction”
USGBC, “LEED® Reference Guide for Building Design and Construction - Healthcare”

General

Commissioning is a systematic quality assurance process to ensure a project is designed to meet the needs of its Owners, and is built, operated and maintained as intended by its Design Team and its Owners.

- Commissioning helps a project achieve its schedule, budget and quality goals by utilizing the University's vast design, construction, operation and maintenance experience to proactively identify and help resolve issues as early and inexpensively as possible.
- Commissioning generally begins during Programming and ends after Occupancy.
- Commissioning focuses on the project's exterior envelope, utilities, mechanical systems, electrical systems, plumbing systems and "powered" architectural systems.
- Commissioning verifies conformance with the project’s design intent as documented in the Owner’s Project Requirements (OPR) and Basis of Design (BOD) documents.

- Commissioning verifies that completed systems and equipment perform as intended in all modes of operation and under all operating conditions. It does not duplicate or substitute for code inspection. It does not provide routine quality control such as inspections for material substitutions, point-to-point wiring checks or poor quality workmanship.
- The U-M Cx process is similar to Cx processes promoted by several national organizations, but it involves more comprehensive design reviews and more extensive construction testing. Detailed U-M Cx procedures ensure consistency among projects.

The U-M Building Commissioning Process

New buildings and major building renovations will undergo design-phase and construction-phase commissioning. On a project pursuing LEED certification, the commissioning will include additional activities to earn several commissioning-related LEED points. Most smaller projects will undergo construction-phase commissioning only. Commissioning activities will be coordinated by a U-M assigned Commissioning Authority (CxA).

Design-Phase Commissioning

Design-phase commissioning generally will begin during Programming and will continue until the project is bid.

The CxA will participate in the mechanical, electrical and plumbing (MEP) design coordination meetings and perform the following tasks. Incorporate the CxA's input in the project's design.

- The CxA will promote adherence to the U-M Design Guidelines, Master Specifications, Standard Details and Preferred Manufacturers Lists.
- The CxA will promote adherence to the U-M energy and water conservation, sustainability and LEED certification initiatives. See Design Guidelines SID-D and SID-K.
- The CxA will provide "lessons learned" from previous U-M projects.
- The CxA will promote the use of construction mock-ups and other quality assurance techniques.
- The CxA will request that equipment maintenance access spaces be shown on the project's plan drawings.
- The CxA will provide input on the Owner's Project Requirements and Basis of Design documents. See Design Guideline SID-B.
- The CxA will participate in the Owner's reviews of design documents and will provide written comments. See Design Guideline SID-L.
- The CxA will participate in the value engineering effort and recommend cost saving measures.

During the Construction Documents (CD) design phase, the CxA will prepare a project-specific Commissioning Specification Section 01710 or 01715. Insert this section in the project's Division 1 specifications to define the Contractors' commissioning requirements during construction. In addition, reference this Commissioning Specification section in the Division 2 through 16 specification sections for the systems and equipment which require commissioning.

MEP Design Coordination

A few major building projects will undergo an enhanced form of design-phase commissioning called MEP design coordination.

The CxA will direct the MEP design activities. Coordinate with the CxA on all MEP issues. Copy the Project Team on all communications.

The CxA will conduct the MEP design coordination meetings and perform the following tasks. Work with the CxA to issue meeting agendas. The CxA will invite the appropriate U-M personnel and conduct the meetings. Present your drawings and specifications for detailed discussion. Publish detailed meeting minutes for CxA review within two weeks of each meeting.

- The CxA will coordinate with Plant Operations, Department of Public Safety (DPS), and Occupational Safety and Environmental Health (OSEH) personnel for their input on MEP issues.
- The CxA will resolve conflicting Owner's review comments related to the MEP design, and will assign action codes to the review comments.
- The CxA will identify special requests that are not cost effective or that exceed the project's scope.
- The CxA will serve as the point of contact for the Owner's review of technical studies including studies on sound, vibration, smoke purge, dispersion, electrical capacity, and energy and water conservation.

Construction-Phase Commissioning

Construction-phase commissioning generally will begin during Owner's review of the Design Development phase design documents, and will continue through initial occupancy.

Construction-phase commissioning will be performed by a Commissioning Team typically consisting of the U-M Project Manager and representatives from the Construction Manager or General Contractor, Trade Contractors, Owner's Representatives, and Plant Operations. The team will be directed by the CxA. Provide an A/E representative to this Cx Team.

Depending upon project size, the CxA will coordinate the activities listed in either the "Full Project Commissioning" procedure or the "Project Commissioning on Small Projects" procedure referenced in the list of U-M Building Commissioning Documents. Assist the CxA with these activities.

Quality Assurance

Throughout design-phase and construction-phase commissioning, the CxA will request that "lessons learned" be documented in meeting minutes, RFI responses, open issues logs, construction reports, and similar project documents. As one means of continually improving the U-M design, construction and commissioning processes, these lessons learned will be incorporated in the appropriate Building Commissioning Documents, U-M Design Guidelines and U-M Master Specifications. They will be forwarded as appropriate to the University Architect, the Associate Director of Design and Construction, and the AEC Sustainability Team.

DESIGN-PHASE COMMISSIONING

This procedure defines the process for performing design-phase commissioning (Cx) on new building, building addition and building renovation projects. When performed by an external commissioning firm, it shall be performed in accordance with the U-M “Terms and Conditions for Professional Services” available at <http://www.umaec.umich.edu/for.archs/Standard.html>.

Design-phase Cx is a process by which a building Commissioning Authority (CxA) assists the U-M Design Manager by participating in the technical aspects of the mechanical, electrical and plumbing (MEP) design. Final decisions related to the project’s scope, schedule, budget and design will remain the responsibility of the Design Manager, but the CxA shall provide the Design Manager with recommendations on the MEP design to assure the MEP is designed as intended by its Design Team and its Owners. The scope of work shall consist of all activities identified below. Design-phase Cx shall begin during Programming and continue until the end of CD design.

All work shall be performed in accordance with Federal, State, University of Michigan, UMHHC and Construction Manager (CM) or General Contractor (GC) safety requirements for working on University property. These requirements include but are not limited to following security and access control procedures, wearing mandated personal protective equipment, and attending a site-specific safety training orientation prior to entering construction zones.

1. Become knowledgeable about the project.
 - Attend at least one presentation by the Architect/Engineer (A/E) to become familiar with the project’s scope, schedule, budget and design intent.
 - Review available program documents to learn about the project scope, including:
 - Number of floors, square footage of each floor, extent of new building or addition work, extent of renovation work, division of space by function (clinical, laboratory, classroom, office, support space), division of space among departments, etc.
 - Connections to and interactions with surrounding buildings, including any related renovations in surrounding buildings.
 - Site requirements including proposed grade, roadway and utility changes.
 - Schedule for the schematic design (SD), design development (DD) and construction documents (CD) design phases, and for project bidding and award.
2. Become knowledgeable about and promote adherence to the U-M design standards (Design Guidelines, Master Specifications, Standard Details, Preferred Manufacturers Lists and Design Deliverables list). Recommend that deviations from these standards be approved by the Design Manager and documented in memos, emails or meeting minutes.
3. As early in design as possible, promote the incorporation of global sustainability issues. See Design Guidelines SID-D and SID-K.

- Explain SID-D and SID-K in detail to the A/E and promote the early identification of energy conservation measures.
 - Promote optimization of the building's aspect ratios, siting, glass orientation, glass area, glass type, exterior shading, daylighting features, roof sections, envelope insulation, air and water barriers, etc.
4. Participate in the A/E's development and maintenance of the Owner's Project Requirements (OPR) document.
 - Review User group meeting minutes and room data sheets produced by the A/E, Hospital Planner, Laboratory Planner, etc. for key project requirements that should be included in the OPR.
 - Help the A/E document the Users' expectations, goals, benchmarks and acceptance criteria for judging the project. Include issues such as indoor temperature and humidity limits, air change rates, air flow rates, sound and vibration limits, medical and laboratory gas needs, laboratory equipment needs, light levels and controls, telecommunications needs, audio/visual needs, access control and security needs, medical systems and equipment needs, training needs, etc.
 - Ask detailed questions to obtain specific acceptance criteria for systems and equipment.
 - Emphasize to the User groups the importance of establishing acceptance criteria early. Describe the high costs of expanding or changing acceptance criteria later.
 - Periodically review the OPR and identify missing, incomplete and incorrectly documented project requirements.
 5. Participate in the MEP design meetings.
 - Help the Design Manager determine the appropriate U-M personnel to invite.
 - Review the A/E's latest design including their concepts, drawings and specifications.
 - Discuss the acceptability of the current concept for each system and the design proposed to achieve that concept.
 - Discuss code, OPR and U-M design standard compliance.
 - Explain that the construction-phase CxA will provide a project-specific specification Section 01715 for incorporation in the project's Division 1 specifications.
 - Recommend that all specification sections for systems and equipment which require commissioning reference Section 01715.
 - Identify incomplete design issues and non-compliance with the Design Deliverables list.
 - Recommend the A/E publish detailed meeting minutes.
 - Recommend the meeting minutes include an action items list at the end.
 6. Recommend the A/E request proposals on technical studies, including studies on sound, vibration, smoke purge, dispersion, electrical capacity, and energy and water conservation. Emphasize the study reports will dictate many design issues, so they should be completed ASAP to minimize redesign.
 7. Recommend Plant Operations, Department of Public Safety (DPS), Occupational Safety and Environmental Health (OEH), UH FP&D, and other U-M non-User personnel be contacted for their input on MEP issues.

8. Participate in the A/E's development and maintenance of the Basis of Design (BOD) document.
 - Periodically review meeting minutes, the latest design drawings and specifications, and the room data sheets. Verify the BOD reflects the Owner's project requirements as stated in the OPR.
 - Periodically review the BOD for clarity, completeness, and documentation of deviations from the U-M design standards. Identify missing, incomplete and incorrectly documented bases of design.
 - Recommend the BOD contain adequate sequences of operation and acceptance criteria to commission the MEP systems and equipment.
9. Become fully knowledgeable of and promote adherence to the U-M design standards. Evaluate deviations for acceptability. Recommend that deviations be documented in memos or meeting minutes, and in the BOD.
10. Provide the A/E with typical U-M controls drawings and promote adherence to these drawings.
11. Promote adherence to the U-M energy and water conservation measures and sustainability initiatives. See Design Guidelines SID-D and SID-K.
 - Review the A/E's Energy and Water Conservation Reports and Energy Impact Statements for errors and omissions.
 - Recommend that major energy conservation measures such as envelope insulation and fenestration be optimized.
12. Provide "lessons learned" from previous U-M projects.
13. Promote the use of construction mock-ups and other quality assurance techniques, and participate in the evaluation of MEP-related mock-ups.
14. Recommend that equipment maintenance access spaces, such as coil and tube pull spaces and electrical working spaces be accounted for in the MEP design and blocked out on plan drawings.
15. Recommend means are provided for performing MEP maintenance.
 - Verify lifting rails are provided above boilers and chillers for hoisting end caps.
 - Verify means exist for replacing large pumps, large motors and other heavy equipment.
 - Verify building egress paths exist for large equipment such as boilers, chillers and substations.
16. Review and submit written comments to the A/E on the project's SD design documents during the Owner's review of the SD documents. See Design Guideline SID-L.
 - Verify the documents accurately reflect the OPR and BOD.
 - Identify errors or omissions related to design, code, the U-M design standards, agreements made during MEP design meetings, and good engineering practice.

17. Assist the Design Manager by assigning action codes to the MEP-related SD, DD and CD phase Owner's review comments.
 - Resolve conflicting review comments related to the MEP design.
 - Inform the Design Manager of special requests from Users and other U-M reviewers that are not cost effective or that will result in scope creep.
 - Indicate which comments should be incorporated and which ones should not be incorporated.
18. Participate in the SD, DD and CD phase cost estimate reconciliation efforts.
 - Spot-check for estimate errors and omissions.
 - Check for line items duplicated in multiple sections and line items assigned to the wrong funding sources.
19. Participate in the SD, DD and CD phase value engineering (VE) efforts.
 - Recommend VE measures if they have little or no effect on compliance with the OPR.
 - Discourage proposed VE measures that significantly reduce OPR compliance, energy or water conservation, reliability or maintainability.
 - Verify that approved VE measures appear in the next phase of design documents.
20. Review and submit written comments to the A/E on the project's DD design documents during the Owner's review of the DD documents.
 - Verify the documents accurately reflect the OPR and BOD.
 - Review comments submitted during the SD phase Owner's review and verify they were addressed.
 - Identify errors or omissions related to design, code, the U-M design standards, agreements made during MEP design meetings and VE meetings, and good engineering practice.
 - Verify the documents include complete testing and acceptance criteria for the systems and equipment being commissioned. Resolve issues that will otherwise inhibit commissioning of the project.
21. During the CD design phase, the construction-phase CxA must edit a U-M Master Specification Section 01710 or 01715 on Commissioning. Recommend this Cx spec section be incorporated by the A/E into the project's Division 1 specifications.
22. Assist with the Owner's review of technical studies, including studies on sound, vibration, smoke purge, dispersion, electrical capacity, and energy and water conservation. Review reports and identify obvious erroneous assumptions or conclusions and return the comments to the A/E.
23. Review and submit written comments to the A/E on the project's CD design documents during the Owner's review of the CD documents.
 - Verify the documents accurately reflect the OPR and BOD.
 - Review comments submitted during the DD phase Owner's review and verify they were addressed.

- Identify errors or omissions related to design, code, the U-M design standards, agreements made during MEP design meetings and VE meetings, and good engineering practice.
- Verify the documents reflect recommendations contained in the technical studies. This includes recommendations on architectural issues such as envelope and fenestration improvements which affect MEP issues such as energy efficiency.
- Verify the documents include complete testing and acceptance criteria for the systems and equipment being commissioned. Identify issues that will inhibit commissioning of the project.

MEP DESIGN COORDINATION

This procedure defines the process for performing mechanical, electrical and plumbing (MEP) design coordination on new building, building addition and major renovation projects. When the process is performed by an external commissioning firm, it shall be performed in accordance with the U-M “Terms and Conditions for Professional Services” available at <http://www.umaec.umich.edu/for.archs/Standard.html>.

MEP design coordination is a process by which one or more building Commissioning Authorities (CxAs) assist the U-M Design Manager by actively coordinating and managing (not just passively observing) all technical aspects of the MEP design. Final decisions related to the project’s scope, schedule and budget will remain the responsibility of the Design Manager, but the CxAs shall assure the MEP is designed as intended by its Design Team and its Owners. The scope of work shall consist of all activities identified below. MEP design coordination shall begin during Programming and continue until the project is bid and awarded.

All work shall be performed in accordance with Federal, State, University of Michigan, UMHHC and Construction Manager (CM) or General Contractor (GC) safety requirements for working on University property. These requirements include but are not limited to following security and access control procedures, wearing mandated personal protective equipment, and attending a site-specific safety training orientation prior to entering construction zones.

1. Become knowledgeable about the project.
 - Attend at least one presentation by the Architect/Engineer (A/E) to become familiar with the project’s scope, schedule, budget and design intent.
 - Review available program documents to learn about the project, including:
 - Number of floors, square footage of each floor, extent of new building or addition work, extent of renovation work, division of space by function (clinical, laboratory, classroom, office, support space), division of space among departments, etc.
 - Connections to and interactions with surrounding buildings, including any related renovations in surrounding buildings.
 - Site requirements including proposed grade, roadway and utility changes.
 - Schedule for the schematic design (SD), design development (DD) and construction documents (CD) design phases, and for project bidding and award.
2. Become knowledgeable about and promote adherence to the U-M design standards (Design Guidelines, Master Specifications, Standard Details, Preferred Manufacturers Lists and Design Deliverables list). Insist that deviations from these standards be approved by the Design Manager and that deviations be documented in memos, emails or meeting minutes.
3. As early in design as possible, promote the incorporation of global sustainability issues. See Design Guidelines SID-D and SID-K.

- Explain SID-D and SID-K in detail to the A/E and promote the early identification of energy conservation measures.
 - Promote optimization of the building's aspect ratios, siting, glass orientation, glass area, glass type, exterior shading, daylighting features, roof sections, envelope insulation, air and vapor barriers, etc.
4. Conduct an MEP design coordination kick-off meeting.
 - Explain the purpose for and format of the MEP design coordination process.
 - Insist the A/E communicate with Plant Operations, UH FP&D, and other U-M non-User groups through you.
 - Insist the A/E inform the Design Manager and you of all MEP decisions affecting schedule or budget.
 - Explain the construction-phase commissioning process.
 - Explain the construction-phase CxA will provide a project-specific specification Section 01715 for incorporation in the project's Division 1 specifications.
 - Insist that all specification sections for systems and equipment which require commissioning reference Section 01715.
 - Follow the AEC Commissioning Group's kick-off meeting standard agenda.
 5. Assist in the A/E's development and maintenance of the Owner's Project Requirements (OPR) document.
 - Participate in sufficient A/E meetings with User groups to learn the Users' MEP needs.
 - Review User group meeting minutes and room data sheets produced by the A/E, Hospital Planner, Laboratory Planner, etc. for key project requirements that should be included in the OPR.
 - Help the A/E document the Users' expectations, goals, benchmarks and acceptance criteria for judging the project. Include issues such as indoor temperature and humidity limits, air change rates, air flow rates, sound and vibration limits, medical and laboratory gas needs, laboratory equipment needs, light levels and controls, telecommunications needs, audio/visual needs, access control and security needs, medical systems and equipment needs, training needs, etc.
 - Ask detailed questions to obtain specific acceptance criteria for systems and equipment.
 - Emphasize to the User groups the importance of establishing acceptance criteria early. Describe the high costs of expanding or changing acceptance criteria later.
 - Review each revision of the OPR and identify missing, incomplete and incorrectly documented project requirements.
 6. Coordinate the MEP design meetings.
 - Coordinate with the A/E to develop and issue meeting agendas.
 - Inform the Design Manager of the appropriate U-M personnel to invite.
 - Ask the A/E to distribute their design documents in advance when possible.
 7. Conduct the MEP design meetings.
 - Require the A/E to present their design including concepts, drawings and specifications.

- Lead a detailed discussion on the acceptability of the current concept for each system and the design proposed to achieve that concept.
 - Discuss code, OPR and U-M design standard compliance.
 - Identify incomplete design issues and enforce the Design Deliverables list requirements for design completeness.
 - Insist the A/E publish detailed meeting minutes for your review within two weeks of each meeting.
 - Insist the meeting minutes include an action items list at the end.
8. Require the A/E to request proposals on technical studies, including studies on sound, vibration, smoke purge, dispersion, electrical capacity, and energy and water conservation.
 - Emphasize the study reports will dictate many design issues, so they should be completed ASAP to minimize redesign.
 - Assist with reviewing the proposals and getting the studies under contract.
 9. Coordinate with Plant Operations, Department of Public Safety (DPS), Occupational Safety and Environmental Health (OSEH), UH FP&D, and other U-M non-User personnel for their input on MEP issues.
 - Assure these organizations are solicited for input when appropriate.
 - Challenge requests from these organizations if the requests appear excessive, especially if they exceed codes or standards.
 10. Promote the A/E's development and maintenance of the Basis Of Design (BOD) document.
 - Periodically review meeting minutes, the latest design drawings and specifications, and the room data sheets. Verify the BOD reflects the Owner's project requirements as stated in the OPR.
 - Review each revision of the BOD for clarity, completeness, and documentation of deviations from the U-M design standards. Identify missing, incomplete and incorrectly documented bases of design.
 - Insist the BOD contain adequate sequences of operation and acceptance criteria to commission the MEP systems and equipment.
 11. Become fully knowledgeable of and require adherence to the U-M design standards. Evaluate deviations for acceptability. Assure deviations are approved by the Design Manager and are documented in memos or meeting minutes, and in the BOD.
 12. Provide the A/E with typical U-M controls drawings and promote adherence to these drawings.
 13. Require adherence to the U-M energy and water conservation measures and sustainability initiatives. See Design Guidelines SID-D and SID-K.
 - Review the A/E's Energy and Water Conservation Reports and Energy Impact Statements for errors and omissions.
 - Insist that major energy conservation measures such as envelope insulation and fenestration be optimized.

14. Help identify major equipment that must be pre-purchased to maintain project schedule or to improve quality. Participate in the development of the pre-purchase specifications and the evaluation of the pre-purchase bids.
15. Provide “lessons learned” from previous U-M projects.
16. Promote the use of construction mock-ups and other quality assurance techniques, and participate in the evaluation of MEP-related mock-ups.
17. Require that equipment maintenance access spaces, such as coil and tube pull spaces and electrical working spaces be accounted for in the MEP design and blocked out on plan drawings.
18. Assure means are provided for performing MEP maintenance.
 - Verify lifting rails are provided above boilers and chillers for hoisting end caps.
 - Verify means exist for replacing large pumps, large motors and other heavy equipment.
 - Verify building egress paths exist for large equipment such as boilers, chillers and substations.
19. Review and submit written comments to the A/E on the project’s SD design documents during the Owner's review of the SD documents. See Design Guideline SID-L.
 - Verify the documents accurately reflect the OPR and BOD.
 - Identify errors or omissions related to design, code, the U-M design standards, agreements made during MEP design meetings, and good engineering practice.
20. Assist the Design Manager by assigning action codes to the MEP-related SD, DD and CD phase Owner’s review comments.
 - Resolve conflicting review comments related to the MEP design.
 - Inform the Design Manager of special requests from Users and other U-M reviewers that are not cost effective or that will result in scope creep.
 - Indicate which comments should be incorporated and which ones should not be incorporated.
21. Participate in the SD, DD and CD phase cost estimate reconciliation efforts.
 - Spot-check for estimate errors and omissions.
 - Check for line items duplicated in multiple sections and line items assigned to the wrong funding sources.
22. Participate in the SD, DD and CD phase value engineering (VE) efforts.
 - Recommend VE measures if they have little or no effect on compliance with the OPR.
 - Discourage proposed VE measures that significantly reduce OPR compliance, energy or water conservation, reliability or maintainability.
 - Verify that approved VE measures appear in the next phase of design documents.
23. Review and submit written comments to the A/E on the project’s DD design documents during the Owner's review of the DD documents.

- Verify the documents accurately reflect the OPR and BOD.
 - Review comments submitted during the SD phase Owner's review and verify they were addressed.
 - Identify errors or omissions related to design, code, the U-M design standards, agreements made during MEP design meetings and VE meetings, and good engineering practice.
 - Verify the documents include complete testing and acceptance criteria for the systems and equipment being commissioned. Resolve issues that will otherwise inhibit commissioning of the project.
24. During the CD design phase, the construction-phase CxA must edit U-M Master Specification Section 01715 titled "Full Project Commissioning". Assure this Cx spec section is submitted in a timely manner and is incorporated by the A/E into the project's Division 1 specifications.
- Coordinate the names and numbers of the related Division 1 specification sections.
 - Help identify systems to be commissioned and make the specification project specific.
25. Serve as the point of contact for the Owner's review of the technical studies on sound, vibration, smoke purge, dispersion, electrical capacity, and energy and water conservation. Review reports and identify obvious erroneous assumptions or conclusions. Coordinate the review of studies by appropriate U-M departments, consolidate review comments and return the comments to the A/E.
26. Review and submit written comments to the A/E on the project's CD design documents during the Owner's review of the CD documents.
- Verify the documents accurately reflect the OPR and BOD.
 - Review comments submitted during the DD phase Owner's review and verify they were addressed.
 - Identify errors or omissions related to design, code, the U-M design standards, agreements made during MEP design meetings and VE meetings, and good engineering practice.
 - Verify the documents reflect recommendations contained in the technical studies. This includes recommendations on architectural issues such as envelope and fenestration improvements which affect MEP issues such as energy efficiency.
 - Verify the documents include complete testing and acceptance criteria for the systems and equipment being commissioned. Identify issues that will inhibit commissioning of the project.
27. Participate if invited to bid evaluations and Bidder pre-award interviews.
28. Help the construction-phase CxA become familiar with the OPR and BOD requirements.

FULL PROJECT COMMISSIONING

This procedure defines the process for performing full construction-phase commissioning (Cx) on new building, building addition and major renovation projects. When the process is performed by an external commissioning firm, it shall be performed in accordance with the U-M “Terms and Conditions for Professional Services” available at <http://www.umaec.umich.edu/for.archs/Standard.html>.

Construction-phase commissioning is a process by which a building Commissioning Authority (CxA) verifies the project is built, operated and maintained as intended by its Design Team and its Owners. The scope of work shall consist of all applicable activities identified below. Construction-phase commissioning shall begin during the design development (DD) phase on a LEED project, or during the construction documents (CD) phase on a non-LEED project. It shall continue through Substantial Completion (SC) and occupancy.

All work shall be performed in accordance with Federal, State, University of Michigan, UMHHC and construction manager (CM) or general contractor (GC) safety requirements for working on University property. These requirements include but are not limited to following security and access control procedures, wearing mandated personal protective equipment, and attending a site-specific safety training orientation prior to entering construction zones.

1. Visit and become familiar with the project site.
2. If the project is pursuing LEED Certification, review and submit written comments to the A/E on the DD level Owner’s Project Requirements (OPR) and Basis of Design (BOD) documents.
3. If the project is pursuing LEED Certification including the LEED Credit “Enhanced Commissioning”, review and submit written comments to the A/E on the project’s DD design documents during the Owner’s Review of the DD documents.
 - Verify the DD documents accurately reflect the OPR and BOD.
 - Verify the DD documents employ good design practices.
4. Using the completed DD design documents, edit U-M Master Specification 01715, "Full Project Commissioning".
 - Coordinate the names and numbers of the related Division 1 specifications.
 - Identify systems to be commissioned and make the specification project specific.
 - Submit the specification to the Architect/Engineer (A/E) (through the U-M Design Manager) for incorporation in the CD specifications.
5. Review and submit written comments to the A/E on the project’s CD design documents during the Owner’s review of the CD documents.

- Verify the CD documents accurately reflect the OPR and BOD.
 - Verify the CD documents include all commissioning-related issues. Identify errors and omissions that will inhibit commissioning of the project.
 - Verify the CD documents include complete performance and acceptance criteria for the systems and equipment being commissioned.
6. Develop a project-specific commissioning manual. Utilize the U-M "Generic Sample Commissioning Manual" available at <http://www.umaec.umich.edu/for.archs/Com.html> and make it project specific. This manual will be the commissioning plan.
 7. Conduct an on-site commissioning kick-off meeting.
 - Require each contractor's lead field person and commissioning lead person to attend.
 - Clarify the requirements and benefits of the commissioning process.
 - Write and distribute commissioning meeting minutes.
 8. Issue the project-specific Cx manual to the CM or GC. Instruct them on how to maintain and complete it.
 - Develop and issue the draft Cx forms for contractor completion and insertion into the Cx manual.
 - Require each contractor to complete, sign, and insert the portion of each form that relates to their work.
 - Require each contractor to insert copies of all manufacturer inspection, start-up and field service reports.
 - Require each contractor to insert copies of all lubrication, filter change and maintenance records on systems and equipment used for temporary service.
 9. Conduct periodic on-site commissioning meetings typically once every month early in the project, increasing to once every two weeks during the middle portion of the project, and further increasing to once every week for the last third of the project.
 - Insist upon CM or GC participation in all meetings. Require contractor participation in meetings as appropriate. Notify the Project Manager of contractors who routinely fail to attend.
 - Write and distribute commissioning meeting minutes. Indicate which contractors attended and which failed to attend.
 10. Participate in the contractor shop drawing submittal review process and send comments to the A/E. Review comments should be declarative, assertive and direct.
 - Establish a parallel review process where the A/E considers and incorporates commissioning comments into the A/E's comments, or contacts you to discuss. Copy the Project Manager when submitting comments to the A/E.
 - Review the submittals which are critical to the Cx process.
 - Focus on identifying issues that will prevent successful commissioning. Typical examples include performance data that does not meet project requirements, alarm contacts not provided for DDC, unclear sequences of operation, inadequate service and electrical clearances.

- Generally verify compliance with plans and specifications, and focus on issues that are often overlooked. Typical examples include un-approved manufacturers (including motors provided with equipment), sub-components (such as motors and valves) not in compliance with related specification sections, etc.
 - Obtain a set of the A/E reviewed and stamped submittals for your file. Notify the Project Manager if your comments were not incorporated.
11. Develop the project commissioning sequence, the intent of which is to assure all prerequisites are complete for each system's functional testing.
 - Create system specific progress check sheets for the systems to be commissioned.
 - List the items, in the required sequence, which must be completed before functional testing can occur.
 - Include brief system descriptions with pertinent facts that will assist during commissioning.
 12. Identify equipment or systems (including pre-purchased equipment) requiring factory or on-site testing, or other special documentation.
 - Require such tests be performed. Verify documentation is inserted into the commissioning manual.
 - When the CxA must witness factory tests, the project shall pay for travel-related expenses.
 - Review equipment test reports or similar reports significant to the commissioning effort.
 - Participate in the resolution of issues brought to light as a result of such testing or reports.
 - Document the final resolutions in the Cx manual.
 13. Facilitate integration of commissioning events into the CM's or GC's CPM project schedule.
 - Develop a logical duration, order and timing for each commissioning event, and provide to the CM or GC.
 - Require the CM or GC to account for commissioning events in the project schedule to allow completion of all functional testing activities prior to Substantial Completion.
 - When a system or equipment is being started early to facilitate construction, remind the CM or GC that the early-started systems and equipment shall be commissioned once before start-up and a second time before final acceptance.
 14. Perform periodic on-site construction observation of equipment and materials related to systems being commissioned. Document any quality control deficiencies found.
 - For components critical for a system to deliver the performance required to meet the OPR and BOD, spot check that proper materials and installation methods were utilized. Examples include proper vibration isolation, proper pipe materials and joining methods, ducts and piping properly protected from dirt while stored, improper clearances that will impact performance or maintainability, equipment not installed per manufacturer's recommendations.
 - Spot check equipment and materials such as motorized dampers, motors, specialty duct work, etc., for compliance with specifications and the A/E approved shop drawing submittals.

- Stay alert for and report gross deficiencies such as missing piping expansion loops and relief valves, and sub-standard materials.
 - Maintain an open issues log and frequently provide a copy to the Project Manager and CM or GC.
 - Insist that deficiencies be documented by the CM or GC, and insist they remain on the CM's or GC's list of incomplete and deficient work until they are completely corrected.
15. Facilitate UM Plant Operations, UMHHC, OSEH, and Department of Public Safety participation in special inspections and tests (roofs, sprinklers, elevators, fire alarm systems, security systems, etc.)
 16. Generate Requests For Information (RFIs) to the A/E relating to questions on design intent or functionality issues on commissioned systems, and follow up on closure of all such issues.
 17. Assist the contractor with generating RFIs related to their questions on design intent or functionality issues on commissioned systems, and follow up until closure of all such issues.
 18. Review RFI responses related to commissioned systems and equipment for correctness and project specificity.
 19. Participate in the coordination drawing process.
 - Attend a minimum of five contractor coordination drawing meetings. Monitor the process to verify reasonable coordination is occurring between trades. Report on contractor progress.
 - Assist contractors in identifying required equipment maintenance access and require maintenance access spaces be delineated on the coordination drawings.
 - Ductwork and piping used for temporary heat, temporary ventilation, temporary fire protection or other temporary service often are missed in the coordination drawing process, especially if installed early in construction. Promote inclusion of temporary work to avoid interferences with permanent work.
 - Insist temporary ductwork and piping be installed in accordance with specification requirements for permanent work. There may be an attempt to declare temporary work as permanent later. Therefore, insist temporary duct and pipe routes, hangers, supports, fittings, valves and valve locations, taps and tap locations, wall and floor penetrations, etc. comply with specification requirements for permanent work.
 20. Promote the use of mock-ups to improve quality and reduce re-work. Review and provide comments on completed mock-ups.
 21. Develop, with contractor assistance, pre-installation check sheets.
 - Identify equipment requiring such sheets (all major equipment).
 - Itemize key specification and installation requirements on the check sheets.
 22. Assist the contractor in developing logical and adequate flushing and cleaning plans for plumbing and hydronic piping systems.

- Review the specification requirements for flushing and cleaning, disinfecting and chemical treatment. Validate contractor compliance throughout construction.
 - Review contractor flushing and cleaning plans.
 - Witness 100 percent of the flushing and cleaning of these systems.
 - Assure chemical testing of the cleaned systems.
 - Assure disinfecting of potable water systems.
 - Assure that the initial water treatment of each hydronic system occurs immediately after flushing and cleaning is complete.
 - Assure that chemical treatment is maintained while the system is operated by the contractor. Do this by requiring that validating reports be provided by the chemical services provider and inserted into the Cx manual after every visit.
23. Participate in contractor duct leak testing.
- Review and approve duct leak testing plans.
 - Witness 100 percent of duct leak tests.
 - Witness 100 percent of follow-up leak tests.
24. Develop, with contractor assistance, equipment pre-start check lists.
- Identify equipment requiring such sheets (all major equipment).
 - Review equipment installation/start-up manuals for equipment being commissioned and incorporate manufacturers' requirements into the pre-start check lists.
25. Develop, with contractor assistance, check/test/start (CTS) and functional test procedures.
- Develop forms to document the start-up and initial testing of equipment requiring commissioning.
 - Include all modes and sequences of operation, all interlocks and conditional control responses, and all specified responses to normal, abnormal, and emergency conditions under all operating conditions.
 - When systems or equipment (including pre-purchased equipment) require the manufacturer's presence at start-up, verify a manufacturer's representative is present.
 - Witness the CTS of major equipment.
26. Generate and issue periodic commissioning reports. Identify systems that do not meet the OPR or BOD.
- Immediately before Substantial Completion is declared, publish a report documenting the status of all commissioning activities including incomplete commissioning and problems identified as a result of commissioning.
 - Provide this report to the Project Manager for attachment to the Notice of Substantial Completion.
27. On projects providing a new or replacing an existing power distribution system, participate in the contractor's energization of the system.
- Review the final short circuit, protective device coordination and arc flash hazard study provided by the A/E. Identify secondary fuse sizes, breaker settings and automatic transfer switch settings that are missing.

- The electrical testing agency will document in test reports the fuse sizes, breaker settings and ATS settings installed in most of the equipment. Compare them with the A/E's report and identify discrepancies. Verify with contractor help the fuse sizes and equipment settings not included in test reports to achieve 100 percent verification.
 - The U-M Electrical Inspector will compare the equipment numbers on installed flash hazard labels to the numbers on the equipment. Document that this comparison has been completed, or complete the comparison if any installed labels were not checked.
 - Verify electrical equipment and cables have passed the specified electrical testing.
 - Witness equipment energizations and start-ups of major electrical equipment.
28. Participate in the functional testing and commissioning of each system. Participate in 100 percent of functional testing of major equipment and a spot check of fan coil units, VAV boxes, plumbing fixtures, and similar high unit count equipment.
- Commission project equipment used for temporary heat, temporary ventilation, temporary power or other temporary service twice; once after initial start-up and a second time before being accepted by the University at Substantial Completion.
 - Verify the system and its components are securely mounted, level, clean, lubricated, and in new condition.
 - Verify the system and its components are installed with adequate maintenance accessibility.
 - Witness the testing of all system functions including all modes and sequences of operation, all interlocks and conditional control responses, and all specified responses to normal, abnormal, and emergency conditions under all operating conditions.
 - Participate in the testing of all system controls, safeties, indicators and alarms.
 - Verify the system and components operate per the design intent.
 - Document all issues revealed as a result of commissioning.
 - Verify all documented issues are resolved.
 - Advise the A/E of design problems.
 - Document separately issues that cannot be corrected within the project scope.
29. Assist the contractor in organizing an effective air and water, test and balance (T&B) effort.
- Verify the air and water balances are being performed by the same T&B contractor.
 - Conduct air and water balance "pre balance" conferences.
 - Verify air and water balance procedures proposed by the T&B contractor are appropriate for the project.
 - Monitor air and water balance activities.
 - Review air and water balance reports.
 - Identify incorrectly balanced systems, incomplete balancing, insufficient balancing data, and system deficiencies identified as a result of the balance work.
 - Verify any incomplete T&B work is completed and any system deficiencies identified during the balances are rectified.
30. On projects providing a new or replacing an existing power distribution system, perform a "pull the plug" test of the system.
- Arrange for a test in which normal primary power to the building is shut off.

- Verify engine-generator and/or battery systems start all emergency and standby loads in their required times, and these loads operate as intended.
 - Verify no normal loads receive engine-generator or battery power.
 - Verify all "loss of normal power", "transfer to generator power" and similar alarms function as intended.
 - Arrange for restoration of normal primary power to the building.
 - Verify emergency and standby loads return to normal power and operate as intended.
 - Verify all normal loads resume operation as intended.
 - Verify engine-generator and/or battery systems return to standby mode.
 - Verify all alarms return to normal.
31. Review and approve the project O&M manuals. Verify compliance to Master Specification 01782.
- Verify the manuals are comprehensive and project specific.
 - Verify the manuals contain as-built information showing equipment revisions.
 - Verify the manuals contain full information from equipment nameplates. Clear, legible photographs are acceptable.
 - Verify the manuals contain schedules of maintenance parts such as belts and filters.
 - Verify the manuals contain as-built electrical panel schedules.
 - Verify the manuals are properly distributed to appropriate Owner personnel.
32. Assist the contractor with organizing and conducting Owner training sessions.
- Verify the contractor organizes the vendor training required by the specifications.
 - Determine attendance requirements via communication with the Owner's Plant Operations or UMHC training coordinator.
 - Propose training schedules for Owner approval.
 - Notify Owner's personnel of each training session and track their attendance through completion.
 - Develop an outline style training document generally describing each major system, areas served etc. that will assist maintenance personnel in becoming familiar with each system.
 - Verify that vendors conducting training sessions are fully knowledgeable and prepared to provide thorough training sessions. If a training session is found to be inadequate, insist the session be cancelled and rescheduled.
 - Provide system "overview" training in conjunction with equipment-specific training.
 - Document each training session (trainer, attendance, date, time, location, and brief report).
33. If the project is pursuing the LEED Credit "Enhanced Commissioning", develop a systems manual.
34. Perform commissioning closeout.
- Review and approve the final commissioning manual submittal.
 - Verify that all project commissioning requirements have been met.

35. Generate and issue a final commissioning report within 30 days of Substantial Completion. If commissioning activities are not complete at this time, issue a supplement to the final Cx report when commissioning is finished.
36. If the project is pursuing the LEED Credit “Thermal Comfort-Verification”, facilitate an occupant thermal comfort survey.
- Notify the AEC Sustainability Team of Substantial Completion and provide them with the Facility Manager's contact information.
 - Eight months after Substantial Completion, the Sustainability Team will ask the Facility Manager for an e-mail list of the building's full time occupants.
 - The Team will e-mail an occupant thermal comfort survey to the building's full time occupants. Response time will be limited to ten working days.
 - The Team will collate and summarize the responses, and submit their summary to the CxA and Facility Manager.
 - If the survey responses indicate 20 percent or more of the occupants are uncomfortable, determine if the building is operating outside of the environmental conditions in the OPR.
 - If the building is operating outside of the environmental conditions in the OPR, coordinate with the Facility Manager and maintenance staff, and implement a corrective action plan.
 - Document the survey results and corrective actions taken in the systems manual.
37. If the project is pursuing the LEED Credit “Enhanced Commissioning”, review the project's operation and maintenance approximately nine to ten months after Substantial Completion.
- Review the results of the occupant thermal comfort survey and any corrective actions taken.
 - Review the operation and maintenance of building systems with the maintenance staff and occupants. Identify systems and equipment not being operated or maintained in accordance with the OPR and BOD, and document them in the systems manual.
 - Identify deficiencies requiring contractor correction and facilitate their correction before expiration of the project's warranty.
 - Document in the systems manual any deficiencies not being corrected.

PROJECT COMMISSIONING FOR SMALL PROJECTS

This procedure defines the process for performing construction-phase commissioning (Cx) on small projects, typically projects consisting of a single system with a few pieces of equipment. When the process is performed by an external commissioning firm, it shall be performed in accordance with the U-M “Terms and Conditions for Professional Services” available at <http://www.umaec.umich.edu/for.archs/Standard.html>.

Construction-phase commissioning is a process by which a building Commissioning Authority (CxA) verifies the project is built, operated and maintained as intended by its Design Team and its Owners. The scope of work shall consist of all applicable activities identified below. Construction-phase commissioning shall begin during the construction documents (CD) design phase and continue through Substantial Completion (SC) and occupancy.

All work shall be performed in accordance with Federal, State, University of Michigan, UMHHC and general contractor (GC) safety requirements for working on University property. These requirements include but are not limited to following security and access control procedures, wearing mandated personal protective equipment, and attending a site-specific safety training orientation prior to entering construction zones.

1. Visit and become familiar with the project site.
2. Using the completed DD design documents, edit U-M Master Specification 01710, "Project Commissioning for Small Projects".
 - Coordinate the names and numbers of the related Division 1 specifications.
 - Identify systems to be commissioned and make the specification project specific.
 - Submit the specification to the Architect/Engineer (A/E) (through the U-M Design Manager) for incorporation in the CD specifications.
3. Review and submit written comments to the A/E on the project's CD design documents during the Owner's review of the CD documents.
 - Verify the CD documents accurately reflect the Owner's Project Requirements (OPR) and Basis of Design (BOD).
 - Verify the CD documents include commissioning-related issues. Identify errors and omissions that will inhibit commissioning of the project.
 - Verify the CD documents include complete testing and acceptance criteria for the systems and equipment being commissioned.
4. Develop a project-specific commissioning manual and maintain it throughout construction. Utilize the U-M "Generic Sample Commissioning Manual" available at <http://www.umaec.umich.edu/for.archs/Com.html> and make it project specific. This manual will be the commissioning plan.
 - Develop and issue the draft Cx forms to the GC for contractor completion and return.
 - Require each contractor to complete and sign the portion of each form that relates to their work.

- Require each contractor to submit copies of all manufacturer inspection, start-up and field services reports.
 - Require each contractor to submit copies of all lubrication, filter change and maintenance records on systems and equipment used for temporary service.
 - Collect the completed forms from the GC and insert them into the Cx manual.
5. Conduct periodic on-site commissioning meetings as part of or immediately after the project's regular construction meetings.
 - Verify each contractor's lead field person and/or commissioning lead person is present.
 - Verify contractor participation in the commissioning process.
 - Write and distribute commissioning meeting minutes. Indicate which contractors attended and which failed to attend.
 6. Participate in the contractor shop drawing submittal review process and send comments to the A/E. Review comments should be declarative, assertive and direct.
 - Establish a parallel review process where the A/E considers and incorporates commissioning comments into the A/E's comments, or contacts you to discuss. Copy the Project Manager when submitting comments to the A/E.
 - Review the submittals which are critical to the Cx process.
 - Focus on identifying issues that will prevent successful commissioning. Typical examples include performance data that does not meet project requirements, alarm contacts not provided for DDC, unclear sequences of operation, inadequate service and electrical clearances.
 - Generally verify compliance with plans and specifications, and focus on issues that are often overlooked. Typical examples include un-approved manufacturers (including motors provided with equipment), sub-components (such as motors and valves) not in compliance with related specification sections, etc.
 - Obtain a set of the A/E reviewed and stamped submittals for your file. Notify the Project Manager if your comments were not incorporated.
 7. Identify equipment or systems (including pre-purchased equipment) requiring factory or on-site testing, and other special documentation.
 - Require such tests be performed. Verify documentation is submitted for the commissioning manual.
 - When the CxA must witness factory tests, the project shall pay for travel-related expenses.
 - Review equipment test reports or similar reports significant to the commissioning effort.
 - Participate in the resolution of issues brought to light as a result of such testing or reports.
 - Document the final resolutions in the Cx manual.
 8. Document any quality control deficiencies found during the commissioning process.
 - Maintain an open issues log and frequently provide a copy to the Project Manager and GC.
 - Insist that deficiencies be documented by the GC, and insist they remain on the GC's list of incomplete and deficient work until they are completely corrected.
 9. Facilitate UM Plant Operations, UMHHC, OSEH, and Department of Public Safety participation in special inspections and tests (roofs, sprinklers, elevators, fire alarm systems, security systems, etc.)

10. Generate Requests For Information (RFIs) to the A/E relating to questions on design intent or functionality issues on commissioned systems, and verify closure of such issues.
11. Assist the contractor with generating RFIs related to their questions on design intent or functionality issues on commissioned systems, and follow up until closure of all such issues.
12. Develop, with contractor assistance, Pre-Installation Check Sheets.
 - Identify equipment requiring such sheets (all major equipment).
 - Itemize key specification and installation requirements on the Check-Sheets.
13. Assist the contractor in developing logical and adequate flushing and cleaning plans for plumbing and hydronic piping systems.
 - Review the specification requirements for flushing and cleaning, disinfecting and chemical treatment. Validate contractor compliance throughout construction.
 - Review contractor flushing and cleaning plans.
 - Witness 100 percent of the flushing and cleaning of these systems.
 - Assure chemical testing of the cleaned systems.
 - Assure disinfecting of potable water systems.
 - Assure that the initial water treatment of each hydronic system occurs immediately after flushing and cleaning is complete.
 - Assure that chemical treatment is maintained while the system is operated by the contractor. Do this by requiring that validating reports be provided by the chemical services provider and inserted into the Cx manual after every visit.
14. Participate in contractor duct leak testing.
 - Verify a sampling of ductwork for cleanliness.
 - Witness 100 percent of duct leak tests.
 - Witness 100 percent of follow-up leak tests.
15. Develop, with contractor assistance, equipment pre-start check lists.
 - Identify equipment requiring such sheets (all major equipment).
 - Review equipment installation/start-up manuals for equipment being commissioned and incorporate manufacturers' requirements into the pre-start check lists.
16. Develop, with contractor assistance, check/test/start (CTS) and functional test procedures.
 - Develop forms to document the start-up, initial testing and functional testing of equipment requiring commissioning.
 - Include all modes and sequences of operation, all interlocks and conditional control responses, and all specified responses to normal, abnormal, and emergency conditions under all operating conditions.
 - When systems or equipment (including pre-purchased equipment) require the manufacturer's presence at start-up, verify a manufacturer's representative is present.
 - Witness the CTS of major equipment.
17. Generate and issue periodic commissioning reports. Identify systems that do not meet the OPR or BOD.

- Immediately before Substantial Completion is declared, publish a report documenting the status of all commissioning activities including incomplete commissioning and problems identified as a result of commissioning.
 - Provide this report to the Project Manager for attachment to the Notice of Substantial Completion.
18. On projects providing a new or replacing an existing power distribution system, participate in the contractor's energization of the system.
- Review the final short circuit, protective device coordination and arc flash hazard study provided by the A/E. Identify secondary fuse sizes, breaker settings and automatic transfer switch settings that are missing.
 - The electrical testing agency will document in test reports the fuse sizes, breaker settings and ATS settings installed in most of the equipment. Compare them with the A/E's report and identify discrepancies. Verify with contractor help the fuse sizes and equipment settings not included in test reports to achieve 100 percent verification.
 - The U-M Electrical Inspector will compare the equipment numbers on installed flash hazard labels to the numbers on the equipment. Document that this comparison has been completed, or complete the comparison if any installed labels were not checked.
 - Verify electrical equipment and cables have passed the specified electrical testing.
 - Witness equipment energizations and start-ups of major electrical equipment.
19. Participate in the functional testing and commissioning of each system. Participate in 100 percent of functional testing of major equipment and a spot check of fan coil units, VAV boxes, plumbing fixtures, and similar high unit count equipment.
- Commission project equipment used for temporary heat, temporary ventilation, temporary power or other temporary service twice; once after initial start-up and a second time before being accepted by the University at Substantial Completion.
 - Verify the system and its components are securely mounted, level, clean, lubricated, and in new condition.
 - Verify the system and its components are installed with adequate maintenance accessibility.
 - Witness the testing of all system functions including all modes and sequences of operation, all interlocks and conditional control responses, and all specified responses to normal, abnormal, and emergency conditions under all operating conditions.
 - Participate in the testing of all system controls, safeties, indicators and alarms.
 - Verify the system and components operate per the design intent.
 - Document all issues revealed as a result of commissioning.
 - Verify all documented issues are resolved.
 - Advise the A/E of design problems.
 - Document separately issues that cannot be corrected within the project scope.
20. Assist the contractor in organizing an effective air and water, test and balance (T&B) effort.
- Verify the air and water balances are being performed by the same T&B contractor.
 - Verify air and water balance procedures proposed by the T&B contractor are appropriate for the project.
 - Monitor air and water balance activities.
 - Review air and water balance reports.

- Identify incorrectly balanced systems, incomplete balancing, insufficient balancing data, and system deficiencies identified as a result of the balance work.
 - Verify any incomplete T&B work is completed and any system deficiencies identified during the balances are rectified.
21. On projects providing a new or replacing an existing power distribution system, perform a "pull the plug" test of the system.
- Arrange for a test in which normal primary power to the building is shut off.
 - Verify engine-generator and/or battery systems start all emergency and standby loads in their required times, and these loads operate as intended.
 - Verify no normal loads receive engine-generator or battery power.
 - Verify all "loss of normal power", "transfer to generator power" and similar alarms function as intended.
 - Arrange for restoration of normal primary power to the building.
 - Verify emergency and standby loads return to normal power and operate as intended.
 - Verify all normal loads resume operation as intended.
 - Verify engine-generator and/or battery systems return to standby mode.
 - Verify all alarms return to normal.
22. Review the project O&M manuals for compliance to Master Specification 01782.
- Verify the manuals are comprehensive and project specific.
 - Verify the manuals contain as-built information showing equipment revisions.
 - Verify the manuals contain full information from equipment nameplates. Clear, legible photographs are acceptable.
 - Verify the manuals contain schedules of maintenance parts such as belts and filters.
 - Verify the manuals contain as-built electrical panel schedules.
 - Verify the manuals are properly distributed to appropriate Owner personnel.
23. Assist the contractor with organizing and conducting Owner training sessions.
- Verify the contractor organizes the vendor training required by the specifications.
 - Determine attendance requirements via communication with the Owner's Plant Operations or UMHHC training coordinator.
 - Propose training schedules for Owner approval.
 - Notify Owner's personnel of each training session and track their attendance through completion.
 - Develop an outline style training document generally describing each major system, areas served etc. that will assist maintenance personnel in becoming familiar with each system.
 - Verify that vendors conducting training sessions are fully knowledgeable and prepared to provide thorough training sessions. If a training session is found to be inadequate, insist the session be cancelled and rescheduled.
 - Provide system "overview" training in conjunction with equipment-specific training.
 - Document each training session (trainer, attendance, date, time, location, and brief report).
24. Perform commissioning closeout.
- Review the final commissioning manual.
 - Verify that all project commissioning requirements have been met.

25. Generate and issue a final commissioning report within 30 days of Substantial Completion. If commissioning activities are not complete at this time, issue a supplement to the final Cx report when commissioning is finished.

DRAWING AND CONSTRUCTION DOCUMENT STANDARDS

General

Prepare documents utilizing the standards below. Documents that the Architect/Engineer (A/E) is required to provide include but are not necessarily limited to the following:

- Construction Documents - Drawings.
- Base Drawings for Official U-M Floor Plans.
- Room Numbering/Key Plan Drawings.
- Record Drawings.
- Floor and Site Plans for Public Use.
- Construction Documents – Specifications.

References

[University of Michigan Design Deliverables](#)
[University of Michigan Design Guidelines Preferred Manufacturers List \(PML\)](#)
[University of Michigan Design Guidelines Technical Sections](#)
[University of Michigan Master Specifications](#)
[University of Michigan Standard General Conditions](#)
[University of Michigan Supplemental General Conditions](#)
[University of Michigan Front End Documents](#)
[University of Michigan Standard Details](#)

CAD Standards

The following are University of Michigan Architecture Engineering and Construction (AEC) drawing standards. At the beginning of the project coordinate specific project requirements with the Design Manager.

- Drawings shall be prepared on bond. Standard sheet size is 24 inches wide by 36 inches long. Other drawing sizes require the approval of the Manager of U-M Space Information (arranged through the Design Manager).
- CAD Format: Microstation is preferred. AutoCAD is acceptable.
- Provide one file per floor with no xrefs. Bind and insert and explode any xrefs.
- Explode/drop all attribute data to text using the Express tools or other method.
- Explode/drop all elements down to their basic element types: cells/blocks, lines, arc and polygons.
- Delete all unneeded elements from the file rather than the freezing or turning the layer off.

SID-H

- Line work should be clean. There should not be duplicate or additional overlapping elements or gaps.
- Standard font is Windows True Type Tahoma 1/8" x 1/8". The A/E must obtain approval from the Design Manager to provide a different font.
- Screening, shading, crosshatching, other indications of materials or locations, and text shall not obliterate significant information, and shall be capable of being reproduced without "bleeding" when the document is reduced to half size. Use screen patterns equal to or coarser than 50 percent, 50 line.

- Drawing Information – include the following:

- Include complete index to drawings on first or second sheet of the entire set and on first or second sheet of each series.

When sheets are added or deleted during the course of construction, final Record Drawing set shall have the index updated to reflect the final documents.

- Complete symbol and abbreviation legend(s) applicable to each series (where a series is a subset such as Architectural, Electrical, etc.) shall be included on first or second sheet of each series. It is not necessary to dedicate a whole sheet to legends. (Parts of the legend may be repeated on sheets throughout the sets or series as deemed appropriate by the A/E, but the legend on first or second sheet shall be comprehensive.
- The A/E shall show the location of all equipment in all locations on the drawings using accepted symbols shown in the Legend. Do not rely solely on notes. Examples include, but are not limited to, are: flow control and isolation valves, all types of dampers, turning vanes, access doors, clean-outs, etc.
- Scale shall be indicated by note and by graphic scale bar on each applicable drawing, detail and section. Any numbers or letters associated with the scale bar are to be a minimum 1/8 inch high. Where scale is applicable for entire drawing, scale references to be located near lower right corner of drawing.
- Plan sheets shall have north arrows, and all plans shall be consistent in their north arrow orientation, with the north arrow either oriented to the top or left of the sheet.
- Plan sheets shall include a tagged column grid on all drawing series (civil, architectural, mechanical, etc.), at all design phases.
- Where a portion of a plan or elevation appears on a sheet, a key plan shall be provided in the lower right portion of the drawing area to show the location of that portion relative to the whole.

SID-H

- Cross-reference all plans, elevations, sections, and details as applicable.
- Floor live load capacities shall be listed on drawings.
- Drawings shall clearly distinguish between existing, new, and replacement work.
- Title Block Content:
 - The University will identify the Project Title and project number, which the A/E shall put on each drawing.
 - Sheet title shall be as descriptive as possible, shall always be unique within the drawing set.
 - When submitting to the University any sheet with information not previously submitted, a note shall be included on one of the issuance lines on the title block, indicating purpose of submittal and date. This applies to design review and contract issuances as well as addenda, bulletins, etc. All such notations of issue shall remain on each sheet. In addition to the note on the issuance line, sheets which have already been released for bids shall have changes clearly delineated, by "clouding" or similar means.
 - The title block, located at the lower right corner of the sheet shall contain the following information:
 - University of Michigan building number and building name
 - University of Michigan project number and/or Plant work order number
 - Project title
 - Sheet title
- Plans and specifications issued for regulatory approval shall be sealed by the Architect or Engineer responsible for the work. Each drawing sheet is to include the name and address of the company primarily responsible for its content regardless of whether or not it is the prime design profession for the project.
- The title sheet shall list all applicable building codes for the project, including but not limited to the building code, the electrical code, the mechanical code and the plumbing code. The construction document drawings are to include all information required by the applicable codes to be present on the drawings. .

Base Drawings for Official UM Floor Plans

- Drawings shall be provided in CAD format.

SID-H

- All full height wall lines shall be merged to a single A-WALL level, partial height walls merged to A-WALL-PRHT, all movable partitions to A-WALL-MOVE, all windows/glazing merged to A-GLAZ, all doors merged to A-DOOR etc.
- UM AEC Space Information and FIC maintains standards for Level/Weight/Color/Line. These are the only levels that should be used in floor plans. Contact the Design Manager to obtain a list of these standards.

Room Numbering Assignment Procedure

- Do not assign room numbers. UM Space Information is responsible for all room numbering. Submit floor plans for room numbers to the Design Manager who will forward them to AEC-Floorplans@bf.umich.edu. Submittals of plans should be according to the following schedule:
- **Schematic Design:** Submit pdf's of floor plans for initial room numbering assignments. Plans should display only walls, doors, windows, structural, stairs and toilet rooms. Remove all architectural symbols, references, column lines etc.
- **Design Development/CD Phase:** Submit pdf's showing any architectural changes (walls, doors openings) along with room numbers as assigned at Schematic phase. Indicate areas that have been changed with revision bubbles.
- **Bid/construction Phase:** Provide CAD files of all architectural floor plans for UM to begin creation of official UM floor plans. Include one elevation or section drawing (CAD or pdf) indicating all floor elevations. These drawings will become the base plans for **Official UM Floor Plans (Key Plans)**.

Record Drawings

- The A/E shall require that the contractors submit "Record" drawings for the project at hand and shall revise the permanent record drawings to reflect the as-built changes.
- Submit both a bond copy and an electronic copy of record drawings.
- In addition to a record set of PDFs or TIFFs, include CAD files for all disciplines. Each file should have layers displayed as printed for the Construction Set.

Floor and Site Plans – Public Use

Floor Plans

- Floor plans *should* contain:
 - Walls
 - Doors
 - Windows
 - Stairs
 - Elevators.

SID-H

- Floor Plans **may** contain:
 - Fixed furniture in class rooms, offices, conference rooms, and laboratories (but **should not** contain labels identifying any fixed furniture in these areas)
 - Restroom fixtures
 - Thematic room type floor plans (See Color & Label Guideline below for suggested colors and labels.)
 - Thematic department floor plans, **with the exception of following**, all of which should be labeled as “Support Departments:”
 - Unit for Laboratory Animal Medicine (ULAM)
 - Plant Operations spaces, such as Mechanical, Maintenance, or Custodial
- Floor Plans **should not** contain:
 - Utility tunnel information (tunnel walls, doors to tunnels, and/or access hatches)
 - Mechanical equipment, piping layouts
 - Card access control system information (card reader and control panel locations, and wiring diagrams)
 - Security system information (security sensor, camera, video recorder and control panel locations, and wiring diagrams)
 - Columns and column lines

Site Plans

Site plans should not contain any reference (visual or textual) to utility tunnels, roof access or mechanical and electrical spaces.

Document Format

- Provide one *pdf* file per floor.
- The original size should be either 8.5” x 11” or 11” x 17”.

Color & Label Guideline

A guideline is provided in the Appendix to assist A/Es and is not a requirement.

Direct questions regarding plans for public use to:

Manager, Space Information & FIC
The University of Michigan
Architecture, Engineering & Construction
(734) 615-9023

Specifications Requirements

General

AEC maintains within its Design Guidelines both a [Preferred Manufacturers List](#) and [Technical Sections](#). These components of the Design Guidelines reflect the needs and experiences of the University in regards to the specific equipment being addressed. The A/E shall select manufacturers from the list that are able to supply the products needed for the given project and whenever possible shall include at least three acceptable manufacturers. The Preferred Manufacturers List shall not substitute for the A/E's professional judgment. In the unusual circumstance where the listed products are not suitable, the A/E must present cogent justification for using other products and must obtain the written approval for these products from the Design Manager. The A/E shall incorporate the standards in the Technical Sections in the project specifications.

University Architecture and Engineering maintains a [Master Specification](#) for use by in-house designers. A/Es may use these specifications, but must edit these specifications to make them project specific. However, they should not substitute these specifications for their professional judgment regarding the requirements of each individual project. Use of these specifications will not relieve the A/E from the obligations of the contract, stated or implied, that pertain to their performance or the performance of their product.

The general requirements (Division 1) and technical portions (Divisions 2 through 16) of the specifications may be included on drawings, or in book (project manual) form. Generally, projects with anticipated construction costs of more than 1 million dollars are required to take the project manual approach. Consult with the Design Manager.

On small projects, produce specifications on drawings as follows:

- Arrange Division 1 general requirements and Division 2 through 14 technical specifications at the head of Architectural trade drawings.
- Arrange Division 15 technical specifications at the head of Mechanical trade drawings.
- Arrange Division 16 technical specifications at the head of Electrical trade drawings.

Project manuals must contain Front End Documents in addition to general requirements and technical specifications. See paragraphs below titled "University of Michigan Standard General Conditions" and "Other Standard Documents".

Specification Standard: The University recommends compliance with the principles and practices outlined in the CSI Manual of Practice.

Use of the 3-Part Section Format is mandatory.

Use of the Page Format is encouraged, but is not mandatory.

Use the 1995 CSI MASTER FORMAT Section numbers and titles for organizing Documents and specifications within Project Manuals. Comply with guidelines for contents of each Division and Section of the specifications.

Language and Terminology

Compliance with the recommendations of Manual of Practice Chapter 4 "Specification Language" is strongly encouraged. The following requirements are mandatory:

Write specifications as if addressed to the General Contractor. Do not address specifications to "This Contractor" or "The subcontractor." Where specific parties must be referred to for clarity, use language similar to the following: "Engage a licensed Professional Engineer to perform calculations," or "Require Installer to examine substrate prior to installation."

Eliminate the term "by others" from drawings and specifications. If work is not part of the Contract, say so directly using (N.I.C.) or similar constructions. If, for example, a mechanical item is shown on an architectural sheet for clarity, use the phrase "work of Division 15" or "by mechanical trades."

Eliminate the term "or equal" from specifications. The University requires Contractors to bid only products specified as "approved." List not less than three alternative, equivalent manufacturers for each generic product specified, unless no other equivalent products exist.

University of Michigan Standard General Conditions











































The University maintains its own [Standard General Conditions](#) and [Supplemental General Conditions](#). Obtain a copy of these documents and make sure the specification writer is fully familiar with it.


















In general, Special Conditions are not required. However an A/E may wish to modify language concerning shop drawing review or other items. Coordinate use of Special Conditions with the Design Manager.

Other Standard Documents

The University maintains a series of standard documents coordinated with the Standard General Conditions. Consult with the Design Manager to obtain further information. [Project Manual \(Front End Documents\)](#).

Appendix - Thematic Floor Plan Standards

	Circulation	010	
	Classrooms	100's	
	Classroom	110	
	Classroom Service	115	
	Laboratory Facilities	200's	
	Laboratories	210, 220, 250	Do not label or distinguish between Class, Open and Research Laboratories
	Laboratory Service	215, 225, 255	
	Office Facilities	300's	
	Office	310	
	Office Service	315	
	Conference Room	350	
	Conference Room Service	355	
	Study Facilities	400's	
	Study	410	Use single color for these four room types. Use text and/or furniture layout to distinguish the room types.
	Stacks	420	
	Study / Stacks	430	
	Processing	440	
	Study Service	455	
	Special Use Facilities	500's	
	Athletic or Physical Education	520	Use text to distinguish between the different room types in this section
	Spectator Seating	523	
	Athletic or Physical Education Service	525	
	Media Production	530	
	Media Production Service	535	
	Demonstration	550	
	Demonstration Service	555	
	Greenhouse	580	
	Greenhouse Service	585	
	Armory, Armory Service	510, 515	Contact UM Design Manager or Manager of Space Information for directions.
	Clinic, Clinic Service	540, 545	
	Field Building	560	
	<i>Animal Quarters, Animal Quarters Service</i>	<i>570, 575</i>	<i>Place in Support Facilities (700's)</i>
	General Use Facilities	600's	
	Note: If the building is primarily a general use building (e.g., Student Union) contact the Manager for Space Information for a more detailed Color Legend.		
	Assembly	610	Optional labels: Theater, Concert Hall, Chapel, etc.
	Assembly Service	615	
	Exhibition	620	Optional labels: Museums, Gallery, etc.
	Exhibition Service	625	
	Food Facility	630	Optional labels: Dining Hall, Cafeteria, Snack Bar, Restaurant, etc.
	Food Facility Service	635	
	Day Care	640	
	Day Care Service	645	
	Lounge	650	
	Lounge Service	655	
	Merchandising	660	Optional labels: Bookstore, Post Office, Ticket Office, Travel Office, etc.
	Merchandising Service	665	
	Recreation	670	Optional labels: Exercise Room, Weight Room, Billiards Room, Game Room, etc.
	Recreation Service	675	
	Meeting Room	680	
	Meeting Room Service	685	

Support Facilities		700's and additional Room Types	
	Central Computer or Telecom & Service	710, 715	<i>These spaces should not be labeled nor should they contain any fixed furniture or mechanical information.</i>
	Shop & Service	720, 725	
	Central Storage & Service	730, 735	
	Vehicle Storage & Service	740, 745	
	Central Service & Service	750, 755	
	Hazardous Materials & Service	760, 765	
	Animal Quarters & Service	570, 575	
	Building or Custodial Services	020	
	Mechanical Rooms (including void spaces)	030	
	Unfinished or Shell Space	070	
Health Care Facilities		800's	
	Patient Room	810, 815, 820	Patient Room, Patient Room Service and Patient Bathrooms
	Patient Service	830, 835	Nurse Station & Service
	Patient Treatment & Examination	840, 845	Surgey & Service
	Patient Treatment & Examination	850, 855	Treatment/Examination & Service
	Patient Treatment & Examination	860, 865	Diagnostic Service Lab & Support
	Patient Treatment & Examination	870	Central Supplies
	Public Waiting Room	880	
Residential Facilities		900's	
Contact UM Design Manager or Manager of Space Information			

SID-H-H: CONSTRUCTION DOCUMENTS FOR UMHHC FACILITIES

Related Sections

Basis Guideline: NA

For an explanation of the use of these guidelines, see [“Design Guidelines for UMHHC Facilities”](#)

General

All project deliverables, including meeting minutes, cost opinions, transmittals, drawings, emails and cost opinions, shall include the correct RTN number and CBN number.

Coordinate and communicate with assigned Facilities Planning team, including Mechanical and Electrical Engineers, Interior Designers and Equipment Planners. Coordinate preliminary furniture and equipment layouts. Obtain preliminary equipment cut sheets from Equipment Planner for major or unusual equipment.

Coordinate and communicate with security and telecommunications staff, and special systems vendors as appropriate.

Obtain current key plans from FPD.

Provide final schematic plan in electronic format to FPD for room number assignments in a format compatible with the version of AutoCAD in use by UMHHC Facilities Planning and Development. Electronic files submitted for the assignment of room numbers should be at 1:1 scale and should show new work only. Files should include only walls, doors, windows, and room types (names).

Review structural capacity of building for proposed use.

Conduct thorough code analysis. As appropriate, review proposed design with regulatory authorities.

Obtain pre-design air testing if required by CSA worksheet. A/E shall be responsible for coordinating the schedule and any special needs with the UMHHC Building Manager and respective Air Test & Balance Company. A copy of all completed air test and balance reports shall be forwarded in PDF format to FAC-projectdept@med.umich.edu. The e-mail should contain the project RTN #, CBN # (if available), Project Name, building name, building level and room numbers included in report.

At start of Design Development/Construction Document phase, confirm all assumptions in the Investigative Report, including all field observations.

If room configuration changes, obtain revised room numbering from FPD.

Submit Construction Documents to regulatory agencies if required, including BFS and HFES (submittal fees shall be paid by the A/E and listed as reimbursables on the CSA). UMH Design Manager will advise if preparation of the Operational Narrative will be part of the A/E scope of services. For leased buildings, coordinate submission of documents to local regulatory agencies with building owner's representative, who shall pay the plan review fees. Respond to all regulatory agency comments in writing within one week. Copy all transmittals and correspondence with regulatory agencies to Design Manager and Capital Construction for file.

Confirm security system, fire alarm and other special system assumptions made during the Investigation with the appropriate UMHHC staff.

Include a list of all applicable codes and a code analysis summary on the cover sheet of the Construction Documents.

Provide complete hardware sets and specifications, including all electrical hardware and wiring diagrams. A sequence of operation is to be included with all hardware sets.

Provide complete interior finish schedule and finish specifications for all finish materials as selected by Interior Designer.

Refer to and incorporate UMHHC Design Guidelines.

Project manual specifications are typically only required for AEC managed projects. Project manual shall comply with AEC requirements and conform to the 1995 CSI 16-Division format unless directed otherwise.

Minimum Drawing Requirements

All drawings submitted to UMHHC become the property of UMHHC. No drawings submitted at any stage of a project shall be copyright protected.

Standard drawing sheet size is 22"x34" (ANSI D-size). With permission of the UMHHC Design Manager, 30"x42" (E-size) drawings may be used where the UMH standard D-size would require a scale smaller than 1/8"=1'-0" or where the E-size sheet would allow for a complete floor plan on a single sheet. Final deliverables (as-builts) are to be black ink on white paper. Drawings included for reference must have "For Reference Only by RTN #####" stamped visibly on each reference drawing. Drawing sets are to be rolled, printed side out with titleblock visible. For bulletins or addendums, 8-1/2"x11" (A-size) are acceptable where small sizes are applicable. All final (as-built) submittals shall be accompanied with an electronic copy of the drawing(s) conforming to the standards listed herein for submission of electronic drawing files. Electronic drawing files shall include drawing files in both DWG and PDF format. All drawing sets submitted for review and/or construction are to be uploaded to UMHHC's reproduction website (currently Reprographics One - see [UMH FPD website](#) for link).

All drawing files issued in PDF format should be printed to black, i.e., no linetypes, equipment, furniture, or any other items shall be illustrated in color.

All drawings, including cover sheet, are to be printed on the UMHHC standard titleblock- see UMH FPD website for standard titleblock.

All lines are to be dark with crisp edges.

All text used on drawings shall be a minimum of 3/32" height (at full size) so that it is legible from a half-size set (i.e. 11"x17" for D-size).

Screening, shading, crosshatching and other indications shall not obliterate underlying information, and shall be capable of being reproduced without "bleeding".

All plans in a given project set are to be oriented in the same direction. In all cases, north is to be "up" or to the right. All plan drawings shall have a north arrow.

All floor plan drawings shall include a small scale building key plan with a shaded "area of work".

Building plans are to show a minimum of two vertical column lines and two horizontal column lines with their associated grid bubbles and identifications. Site plans to show a minimum of two coordinate points, preferably at the lower left and upper right of drawing area.

Base Plan Master Files of UMHHC buildings are located in model space according to UMH's survey grid and are available on FPD's virtual network (if AE does not have access to FPD's virtual network, contact your FPD project manager). AE shall maintain FPD's spatial coordinates so that plan sheets may be inserted as overlays to existing electronic drawings (i.e. plan views in CAD files should line up correctly when brought together electronically). Coordinate points should align in each file.

It is extremely important to field verify all dimensions, existing walls, doors, windows, built-ins, power, communications, fire alarm, special electrical systems, HVAC, plumbing, fire protection, etc. Any discrepancies found during design between actual field conditions and Base Plan Master Files are to be documented on marked up plots of the base plan master file(s) in question and communicated to UMHC's FPD CAD Coordinator, Facilities Planning and Development, 2101 Commonwealth, Ann Arbor, MI 48105-5759. Project drawings are to reflect actual field conditions.

Include a complete index of drawings on the cover sheet of the drawing set. All drawings, regardless of set size require a cover sheet. On projects with more than 30 sheets, include an index sheet on the first sheet of each series as well (a series is a segment of the drawing set such as the Architectural series or Electrical series). Index is to identify sheet number and title and indicate clearly if a drawing is included only for information and does not show work under the contract.

If drawings are added or deleted during the course of construction, A/E is to revise the index on the Record drawing set accordingly.

Include a complete symbol and abbreviation legend for each series on the first or second drawing of the series. (A series is a segment of the drawing set such as the Architectural series or Electrical series.).

Include a graphic scale bar on each plan drawing. Where scale applies to the entire drawing, the scale references are to be located near the lower right corner of the drawing area.

Where a portion of a plan or elevation appears on a sheet, use a reference keyplan drawing to show location relative to the whole. The preferred location for the keyplan is in the lower right corner of the drawing or in the titleblock area of the drawing, space permitting.

Cross-reference plans, elevations, sections and details. Identify sections on all plans; architectural, mechanical and electrical.

Distinguish clearly between existing, new, and replacement work.

Clear drawings shall be provided, indicating scope of any required demolition and new construction. All floor plan drawings shall include north arrows, graphic scales, and keyplans. Except for keyplans, a minimum scale of at least 1/8" = 1'-0" is required.

Produce drawings using standard AIA layering standards.

Provide proper line weight differentiation to assist in the readability of drawings.

All external referenced materials should have relative references and should be included with the original referenced drawing. If an external reference is not required in a drawing, the reference should be removed.

Utility shutdown information will be shown on the construction documents. Refer to Divisions 15 and 16 Basic Design Guidelines for specific format.

In order to fully coordinate all systems, architectural reflected ceiling plans are required. They are to show all ceiling mounted equipment including: lights, HVAC supply and return, smoke detectors, speakers, owner equipment, access panels, cameras and security devices, exit signs, IV tracks, curtain tracks, signage, (etc.). Generally equipment should be centered in ceiling tiles.

In renovation projects, existing equipment to remain is to be shown. If existing sprinkler heads are anticipated to remain, they must be shown on the reflected ceiling plan.

In order to provide access above the ceiling, care should be taken to provide "free" tiles, particularly below cable trays, filters, and other areas that require on-going maintenance.

For new and existing plans, fire and smoke rated walls and other assemblies are to be indicated clearly on the drawings. Style of drawing linetype symbols shall match the UMHC Fire Wall Keyplans.

Titleblock Content

Dates Issued: List purpose and date of all issues, including as appropriate, 50% CD, 95% CD, Regulatory Review, Construction and Record Drawings. Every issued document, not submitted for construction or bids, must be labeled "Not For Construction" in the titleblock.

Sheet Number: All drawing numbers are to include a prefix which designates the discipline of work included on the sheet. Examples of appropriate sheet numbers are as follows:

- A-8 Eighth sheet of (A)rchitectural series.
- CL-2 Second Sheet of a series that includes both (C)ivil and (L)andscaping information.
- M-6 Sixth sheet of a series that includes (M)echanical information.

Project Number: Indicate UMHC project number (RTN # & CBN #). For projects managed by UM/Campus AEC, include AEC "P100" number. The first row under "project number" is to be the UM/Campus assigned number and the second row is to be the UMHC RTN & CBN#'s.

Sheet Title: A sheet's title should uniquely identify a drawing sheet from others in a set and identify type of drawing using words such as:

- Plan
- Details
- Sections
- Elevations
- Schedules
- Risers
- Schematics

Identify the location. Where the project area requires multiple plan sheets, include unique building, level and zone in sheet title.

Project: UMHC will provide a specific project name.

Approval/Issuance Area of Titleblock:

Keywords: Identify drawing content with appropriate keywords found in the Disciplines/Keywords table at the end of this document.

Location: Show Building, Level, Zone or other location information which is not already part of the Project Name or Sheet Title.

UM Design Mgr.: Identify the primary University Project Coordinator.

Approved/Checked/Coordination Checked: When submitting to UMHC any sheet with information not previously submitted, note on one of the issuance lines the purpose of submittal and date (i.e. CONSTRUCTION MM/DD/YY). This applies to design review and contract issuances as well as addenda, bulletins, etc. All such notations of issue are to remain on sheets.

Issues for Dates: All documents issued must have a unique, current date. "Issued for" dates shall be noted as follows:

- Schematic Review (as needed)
- ___% DD Review (as needed)
- ___% CD Review (as needed)
- 100% CD Review (mandatory)
- Construction (mandatory)

All drawings issued after the construction set shall be noted "Bulletin #___" as directed by Design Manager. All changes shall be "bubbled" and all drawings shall be reissued as a complete set.

Special Notes for Capital Construction (UM Construction Services) CD's

Smaller construction projects are generally managed by UMH FPD Construction Coordinators, constructed by UM Construction Services and do not go out to bid to General Contractors. Consequently, much of the standard boilerplate and notes required for a competitively bid project are not required.

These projects do not need full specifications or after-hours information. They do need to be prepared with standard UMHHC title block 22"x34" (ANSI D.)

These documents should include all information required to order the materials; i.e. manufacturer and model numbers, colors, sizes, etc.

Documents should include phasing drawings and temporary partition locations, as required.

Obtain all finish information from UMHHC Interior Design and put all information on the documents, including manufacturer, model, color name and all model numbers,

Final construction documents are to be submitted in PDF format to the UMH Design Manager and uploaded to the printing vendor.

A/E will submit documents to BFS and HEFS and include plan submittal fees as reimbursable expenses, as required.

At the end of construction phase of the project AutoCAD & PDF file formats are to be provided to FPD.

Backups

A/E's shall retain available backups of electronic files for a minimum of 5 years from the close of the A/E's contract with UMHHC.

Software Platform

Internally, UMHHC Facilities Planning and Development uses AutoCAD. Electronic files submitted to UMHHC FPD shall be in a format compatible with the release in use by UMHHC FPD and in conformance with the standards outlined herein for electronically prepared drawings.

Electronic File Transmission and Requests

Electronic files submitted to UMHHC Facilities Planning and Development are to be submitted in AutoCAD format with one "hard-copy" sheet per drawing file and conform to standards herein for layer names and drawing content. In addition to AutoCAD files, all drawings shall be submitted in PDF format.

Electronic files submitted to UMHHC Facilities Planning and Development for Interior Design use should be at 1:1 scale and show new work only. File should include only walls, doors, windows, room numbers, room types (names) and locations of electrical and data outlets. Doors should be shown at 90 degrees open. Room numbers and room types should be on one layer.

Electronic files submitted to UMHHC Facilities Planning and Development for the assignment of room numbers should be at 1:1 scale and show new work only. File should include only walls, doors, windows, room numbers and room types (names).

Electronic drawing submittals shall not use external drawing references (x-ref). All external referenced materials should be permanently inserted in the drawing file.

Files translated from CAD programs other than AutoCAD shall have all "numbered" layers removed or replaced with appropriate AIA Guideline type layer names and translation routines should be written accordingly.

Electronic files may be transmitted to UMHC Facilities Planning and Development via e-mail (FAC-projectdept@med.umich.edu), FPD Virtual Network, compact disc or posted to an FTP site accessible to UMHC FPD except for final deliverables (Record Drawings). Final deliverables (Record Drawings) shall be transmitted on compact disc.

Room Numbering

Room numbering shall generally be provided by FPD.

Guidelines for assigning room numbers for University of Michigan Hospitals and Health Centers:

- UMH standard is a 4 digit room number, with the first digit being the floor. Rooms on floors with a 2 digit floor number (B1, 10, etc.) may have a 5 digit room number
- In a simple building start at the primary entrance and work counter-clockwise around the building with odd numbers on the perimeter and even numbers on the core.
- In a large, complex building with the potential to have more than 1000 rooms on a floor, divide the floor into wayfinding zones, each designated by a letter following the floor number. (Example: 1A101) In such cases, the wayfinding zones should correspond to any breakdowns in architectural construction drawings.
- Reserve numbers ending in 0 and 5 for corridors.
- For rooms where the primary entrance is from within another room, label the room number of the room it opens from with a letter suffix (example: where you get to a manager's office by going through the secretary's office, the secretary office would be 1001 and the manager office would be 1001A). Suites where all rooms open off a central core have the number of the central core room with a letter suffix (example, 1001, 1001A, 1001B).
- While they CAN be used in a large suite for general rooms, try to reserve the following letter suffixes for the following specific room types:
 - C—Communication Closets
 - E—Electrical Closets
 - I—avoid using due to confusion with the numeral 1.
 - J—Janitor Closets
 - M—Mechanical Closets
 - O and Q—avoid using due to confusion with the numeral 0.
 - T—Toilet rooms
 - V—Vertical Shafts
 - X—Stairwells and Elevators
 - Z—Corridors
- The above specific room types must have room numbers with the above suffixes (i.e. corridor 1000Z)
- If a room looks like it could be subdivided in the future, skip a number in the sequence to allow for future expansion.
- In an existing building, for a room that has been created by the dividing of a larger room, follow the pattern discernable from the existing surrounding area.
- If a room has 2 entrances assign the number based on which door is the primary entrance. If neither entrance is "primary", use the lower of the two possible room numbers.
- When a room has been created by combining two smaller rooms, use the lower of the existing room numbers.

Door Numbering

Door numbers shall relate to room numbers.

Disciplines/Keywords

Keywords are used by the UMH Archival Coordinator for archiving and logging each construction document sheet into a searchable software database. The following standard keywords (or combination thereof) shall be utilized on all CD sheets to indicate the sheet's content:

PRIMARY DISCIPLINE	KEYWORD	CONTENT/COMMENT
All disciplines	Demolition	Demolition / Existing conditions
	Details	
	Elevations	Interior or Exterior
	Index	
	New Work	
	Notes	
	Riser	
	Schedules	
	Sections	
	Specifications	
	Symbols	abbreviations, legend, key
	Title	
(A)rchitectural	Conveyance	Elevator / Escalator / RoboCarrier / P-Tube Cars, Tracks, Tubes
	Code	Fire/ Smoke Walls
	Dividers	Floor Plans/Information: Includes Partitions, Architectural Specialties, Interior walls.
	Enclosures	Exterior Walls, Windows, Window/Curtain Walls Roofs, roof stairs, Ladders, Railings.
	Equipment	Fixed, Movable & Misc. equipment.
	Finish	Room finish patterns, paint types
	Furniture	Freestanding, Furniture Systems, Plants. Woodwork, Millwork, Casework, Floor Coverings, Custom Cabinetry
	Phasing	Phasing Plans
	Reflected Ceiling	Grid, Penetrations, Suspended Elements
	Signs	Interior and exterior signs.
(C)ivil	Grading	Grading, Retaining walls, test borings, topographical.
	Roadways	Roads, Parking lots
	Survey	Property lines and survey benchmarks
	Utilities	Storm drainage, catch basins, exterior sanitary sewer, manholes, pumping stations, storage tanks, Site electrical substations and poles, Site communication (under/overhead), Fire hydrants and connections, natural gas manholes, meters, vaults and tunnels.
(E)lectrical	Auxiliary Systems	Lightning protection system, grounding system, Other auxiliary systems.
	Communications	Tel and Communication outlets, Data outlets, Sound or PA systems, TV antenna systems, Closed circuit TV, Nurse Call, Security, Paging systems, Central Dictation Systems, Bell systems, Clock systems, Misc. alarm systems, Intercom systems, Cable trays.
	Controls	Electric control systems, devices, wiring, VSD's
	Lighting	Lighting: special, emergency, roof, site; Switches, circuits
	One Line	
	Power	Panels, power equipment, switchboards, circuits, under floor/carpet raceways/wiring, feeders, busways.
	Receptacles	
(F)ire	Dividers	Firewalls
	Sprinklers	Sprinkler system, Standpipe system
(L)andscape	Improvements	Site improvements: fencing, walls, decks, bridges, pools, sports fields, play structures, site furnishings, telephone booths.

	Irrigation	Irrigation
	Planting	Trees, shrubs, flowers
	Walks	Sidewalks, steps
(M)echanical	Controls	Controls and instrumentation
	HVAC	HVAC Systems, diffusers, sheet metal, piping
	Medical Gas	Medical gas systems, Compressed air
	Special Systems	Special systems, Process systems, Dust and fume collection systems, Fuel system, Refrigeration systems, Snow melt systems.
(P)lumbing	Domestic Water	Domestic hot and cold water systems
	Equipment	Fixtures, Sump pumps
	Special Waste Systems	Acid, Alkaline, Oil Waste systems
	Waste Water	Sanitary drainage, Storm drainage systems, Interior
(S)tructural	Beams	lintels
	Columns	Piles/Piers, Anchors
	Foundation	Slab, deck, concrete
	Framing	wind bracing
	Load	
	Truss	

REGULATED AND HAZARDOUS MATERIALS

General

This section addresses the management and disposal of regulated and/ or hazardous materials that may be encountered in construction projects. University of Michigan (U-M) policies require proper management of regulated, hazardous and other construction waste to comply with local, state and federal regulations and to encourage environmental stewardship. Construction materials and waste included in this section are: asbestos containing materials (ACM), CFC & HCFC containing refrigerants, lead, mercury, PCBs, radioactive materials and miscellaneous regulated construction waste. A/Es should be aware that individual projects may encounter other materials requiring special handling that are not outlined in this section. The A/E shall work with the University Project Coordinator to identify a list of materials which are hazardous, regulated and/or require special handling and which are likely to be encountered during demolition and construction.

Related Sections

Design Guideline Technical Sections:

[15515 - Hydronic Specialties](#)

U-M Master Specification:

[01140 - Work Restrictions](#)

[13280 - Asbestos Abatement](#)

[13281 - Abatement of Asbestos-Containing Floor Tile](#)

[13282 - Asbestos Abatement \(Roofing Projects Only\)](#)

[13285 - Lead Products Removal and Disposal](#)

[13286 - Lead Products Removal and Disposal \(Child Care Facilities and Residential Projects\)](#)

[13288 - Regulated Construction Waste Removal, Staging and Disposal](#)

[15250 - Mechanical Systems Insulation](#)

[15515 - Hydronic Systems and Specialties](#)

[16010 - General Electrical Requirements](#)

References

United States Department of Labor, Occupational Safety and Health Administration (OSHA), 29CFR Part 1926: Asbestos in Construction Standard

U-M Occupational Safety and Environmental Health (OSEH) "Asbestos Management Program." (<http://www.oseh.umich.edu/guidacm.pdf>)

U-M OSEH "Spill Prevention Control and Countermeasure Plan & Pollution Incident and Prevention Plan" (<http://www.oseh.umich.edu/SPCC-PIPP.pdf>)

Section 2.6 "Best Management Practices for Lithium Bromide Systems."

Section 2.7 "Best Management Practices for Ethylene Glycol Systems."

U-M OSEH "Lead and Lead-Based Paint Policy and Guidelines."
http://www.oseh.umich.edu/topics_lead.html

United States Department of Labor, Occupational Safety and Health Administration,
29CFR Part 1926.62 and State of Michigan Occupational Safety and Health
Administration (MIOSHA) Rule 325.51991-51992: "Lead in Construction."

United States Environmental Protection Agency EPA 40 CFR 745 "Requirements for
Lead-Based Paint Activities in Target Housing and Child-Occupied Facilities;" and
"Requirements for Hazard Education Before Renovation of Target Housing;" and
"Identification of Dangerous Levels of Lead."

Lead Abatement Act (Michigan Part 54A).

Lead Remediation Rules (MCDH Rule 325).

ASHRAE Standard 15 and Related Revisions: Safety Code for Mechanical
Refrigeration.

ASHRAE Standard 34 and Related Revisions: Number Designation and Safety
Classification of Refrigerants.

United States Environmental Protection Agency (US EPA) requirements of Section 808
(Prohibition of Venting and Regulation of CFC).

MI Public Act 451, Part 121: Liquid Industrial Waste.

Michigan Department of Environmental Quality (MDEQ), Part 31, Water Resources
Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451.

Michigan Department of Environmental Quality (MDEQ), Part 55, Air Pollution
Control, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as
amended (Act 451).

Asbestos and Asbestos-Containing Materials (ACM):

Introduction

The current OSHA asbestos standard requires that products used in the workplace be labeled if they contain greater than 1% asbestos and are likely to result in exposures above the permissible exposure limits during reasonable foreseeable use, handling, storage, disposal, processing, or transportation. Material Safety Data Sheets may contain one of the following synonymous names:

Chemical Name: Magnesium Silicate

Mineral Names: Chrysotile, Amosite, Tremolite, Crocidolite, Anthophyllite,
Actinolite

Common Names: serpentine, amphibole, fibrous grunerite

ACM in Renovation Projects

Many U-M buildings contain ACM, particularly those constructed before the early 1980's. Prior to renovation activities all buildings, *including those built after the 1980's*, must be surveyed for asbestos containing materials. Contact U-M OSEH well in advance of the project to coordinate a survey of building materials for asbestos. Some U-M buildings have already been surveyed for asbestos containing materials. U-M OSEH maintains an ACM database for all U-M buildings previously surveyed for asbestos. OSEH conducts additional tests where required to identify additional ACM not already identified in the database. At U-M, some ACM is labeled in the field, but in many cases, labeling is impractical. Labeling of ACM, if deemed necessary, is generally conducted by OSEH.

In general, U-M strives to remove ACM, as opportunities present themselves. At a minimum, projects that require some abatement are responsible for minimum required abatement. In some cases abatement may be expanded to address all ACM of a certain type in a certain area. Coordinate ACM abatement scope with U-M Project Coordinator and OSEH.

In many cases asbestos abatement projects are designed and conducted by the University, and the University contracts separately for asbestos abatement. Therefore the A/E involved with the design of a renovation project may not be required to include asbestos abatement specifications in the Bid Documents. However, A/Es must make the University Project Coordinator aware if they suspect that asbestos may be encountered due to project activity. In addition, the A/E should advise the Contractor on the construction documents that asbestos may be present in the area or adjacent areas of the renovation project, and to conduct their work accordingly.

Refer to U-M Master Specification Section 15240 regarding reinsulation of abated mechanical insulation.

ACM in New Construction

U-M does not permit the use of new ACM in construction projects. A/Es should be aware that asbestos-containing products may still be legally manufactured, imported and sold in the United States, although very limited quantities are probably produced. Legal products include but are not limited to floor tile, floor tile adhesive, sealants, plaster, and roofing materials. Because of the possibility of encountering ACM, prohibitory language should be added to specification sections covering materials which might contain asbestos.

In the event that a particular performance requirement is identified that can only be satisfied by the use of ACM, the A/E should contact OSEH through the University Project Coordinator and submit a written request for authorization. Approval for new ACM usage must be obtained prior to specification and installation. If approval is received, proper documentation will be coordinated with OSEH.

CFC & HCFC-Containing Refrigerants:

The University requires that all work related to refrigerant contained in chillers, cooling coils, air conditioners, and similar equipment, including related piping, be handled in strict accordance with the referenced standards. A/Es should advise contractors of these requirements. In addition, the University has tracking procedures in place for CFC and HCFC refrigerants. When new refrigeration equipment is installed, when old refrigeration equipment is removed, or when refrigerant is disposed of, include language in the Contract Documents directing the Contractor to inform the Owner's Plant Operations Air Conditioning Shop. Refer to U-M Master Specification Section 01140. Copies of the required form are available at:

http://www.plant.bf.umich.edu/utilities/operations-engineering/CFC_Form.pdf

Recovered refrigerant shall be handled through the U-M Plant Operations Air Conditioning Shop. Direct the Contractor to contact the Plant Operations Air Conditioning Shop to properly handle the recovered refrigerant. In most cases, U-M A/C Shop will remove refrigerant for reclamation.

Ethylene Glycol

Ethylene glycol systems are used on campus in some heating, ventilation and air-conditioning systems. Ethylene glycol is regulated by the State of Michigan as a Liquid Industrial Waste. Consequently, the Contractor's disposal methods are subject to the oversight of U-M OSEH. Where mechanical devices or systems containing ethylene glycol are indicated to be demolished, direct the Contractor to legally dispose of ethylene glycol. The Contractor shall contact U-M OSEH Environmental and Hazardous Materials Management Program (734-763-4568) in the event of an accidental spill of ethylene glycol.

Refer to U-M Design Guideline Technical Section 15515 and U-M Master Specification 15515 for design and installation requirements for glycol systems.

Lithium Bromide

Lithium bromide is used on campus in most absorption chillers. Lithium bromide within these systems is contained within the machinery and does not circulate throughout the building. Where absorption chillers are indicated to be demolished, contact the U-M Plant Operations Air Conditioning Shop to determine whether the recovered lithium bromide can be used in other machinery.

If it is determined that the lithium bromide cannot be used in other machinery and it is to be disposed of, it is subject to regulation by the State of Michigan as a Liquid Industrial Waste. Direct the Contractor to coordinate removal activities with UM OSEH's tracking program and to legally dispose of lithium bromide. The Contractor must contact U-M OSEH Environmental and Hazardous Materials Management Program (734-763-4568) in the event of an accidental spill of lithium bromide.

Lead

Lead may be a component of building materials in many campus buildings. Materials likely to contain lead include latex and oil based paints (especially paints manufactured before 1978), radiation shielding materials, plumbing joints, solder, pipe wrap, flashing and other materials used as soundproofing. Construction activities that may result in lead exposure include sanding, scraping, cutting, grinding, welding and demolition. The University Project Coordinator will arrange to have a lead survey completed early in the design process, through U-M OSEH.

Procedures for working with lead-based paint (LBP) and other lead-containing material (LCM) depend on the type of work being completed and the type of building in which the work is occurring. Of particular concern are construction projects that create lead disturbances in child-occupied facilities (child care centers and family housing). For projects in or affecting child-occupied facilities, A/Es should work with the University Project Coordinator and OSEH early in the design process to develop custom specifications addressing specific project conditions and additional state and federal regulations.

For other University buildings, Master Specification Section 13285 outlines the University policy and procedures that have been developed in conjunction with OSEH to meet all applicable local, state and federal regulations for non-child occupied facilities.

Use of LCM in New Construction

The University discourages the use of new LCM in construction projects. In the event that a particular performance requirement is identified that can only be satisfied by the use of LCM, the A/E should contact OSEH through the University Project Coordinator and submit a written request for authorization. If approval is received, proper documentation will be coordinated with OSEH.

Lubricant or Other Oils

Introduction and Policy

Oils are regulated by the State of Michigan as a Liquid Industrial Waste. Consequently, the Contractor's disposal methods are subject to the oversight of UM OSEH. Where mechanical devices that contain lubricant or other oils are indicated to be demolished, direct the Contractor to legally dispose of the oils. The Contractor must contact UM OSEH Environmental and Hazardous Materials Management Program (734-763-4568) in the event of an accidental spill.

Mercury

Mercury-containing articles and equipment likely to be encountered during construction include but are not limited to controls, thermometers, thermostats, switches, manometers and gauges. Fluorescent lamps also contain mercury. See paragraph below regarding lamp recycling.

SID-I

Mercury-containing articles and equipment are considered regulated construction waste and must be disposed of through the OSEH Environmental and Hazardous Materials Management Program. OSEH will package, pickup and dispose of properly staged Regulated Waste at no cost to the Contractor.

A/Es should direct the Contractor to handle mercury-containing articles and equipment with extreme care to prevent the release of elemental mercury. Mercury-containing articles and equipment must be properly packaged with adequate cushioning in only OSEH-provided containers. In the case of an accidental spill of elemental mercury, the affected area must be immediately evacuated, closed to traffic and OSEH or DPS contacted for clean-up.

PCBs

Bulk Product Waste

PCB (Polychlorinated Biphenyl) bulk product waste refers to waste derived from manufactured products containing PCBs in a non-liquid state. This includes applied dried paints, varnishes, waxes, or other similar coatings or sealants. The University Project Coordinator will arrange to have a PCB survey completed by UM OSEH early in the design process.

A/Es shall direct Contractors to dispose of PCB-containing waste in coordination with OSEH. There are no specific requirements for containerizing or segregating PCB bulk product waste, if the concentration of PCB's is less than 50 parts per million (ppm). It can be disposed with other construction debris in a municipal or non-municipal non-hazardous waste landfill licensed by the State of Michigan, Department of Environmental Quality. If the concentration of PCBs in the waste is greater than 50 ppm, it must be collected by UM OSEH for disposal. Coordination is required, since OSEH must notify the landfill, 15 days in advance, of the type of waste to be disposed. A PCB concentration less than 50 ppm does not require notification.

Liquid Waste (Older Electromagnetic Ballasts)

Older electromagnetic ballasts may contain liquid PCBs. A/Es shall advise the Contractor that the University requires recycling of all fluorescent lighting ballasts, along with tubular fluorescent, compact fluorescent and HID lamps as a part of the OSEH's Environmental Stewardship program. Master specification section 16010, "Basic Electrical Requirements" outlines proper packaging and pick-up requirements for fluorescent lamps and ballasts. Leaking electromagnetic ballasts shall be packaged separately from intact ballasts to avoid contamination. Contractor shall coordinate proper handling, packaging and decontamination of surrounding materials with OSEH for all leaking ballasts. Electronic ballasts do not contain PCB's and are to be packaged separately from electromagnetic ballasts.

Radioactive Materials

Common construction waste that may contain low levels of radioactivity includes but is not limited to smoke detectors and self luminescent exit signs.

Construction waste containing any level of radioactivity must be disposed of through the OSEH Environmental and Hazardous Materials Management Program. OSEH will package, pickup and dispose of properly staged Regulated Waste at no cost to the Contractor. A/Es should advise Contractors to handle and package self luminescent exit signs with extreme care. They contain fragile glass tubes filled with a radioactive gas, and care must be taken not to break the glass during demolition and recycling. Collect the frame of the exit sign as it may contain sign specific information. For radioactive smoke detectors, collect both the top and the bottom of the unit.

There are research laboratories on campus that use radioactive materials. When a lab that uses radioactive materials relocates or discontinues radioactive research, the lab will undergo a strict decommissioning process in coordination with OSEH Radiation Safety Services. If an A/E suspects that the radioactive materials may have been present in an area which will undergo renovation, immediately notify the University Project Coordinator, who will contact OSEH in order to schedule decommissioning. This process will be completed before a construction project is undertaken.

Regulated Construction Waste

The term “Regulated Waste” refers to building equipment or materials that will be demolished as part of a renovation or construction project, but cannot be disposed of as typical construction and demolition debris. Materials include but are not limited to the following:

- Batteries, including but not limited to lead-, nickel- and or mercury-containing batteries from exit signs, smoke detectors and backup power sources.
- Containers of paint and paint related materials, cleaners, pesticides, compressed gas cylinders and portable fuel cans.
- Fire extinguishers.

OSEH will package, pickup and dispose of properly staged Regulated Waste at no cost to the Contractor, provided that the waste has actually been removed from UM buildings. A/Es should instruct the Contractor to Contact OSEH Environmental and Hazardous Materials Management Program (734-763-4568) to schedule a pickup immediately after regulated waste has been staged. Incidental Regulated Waste that is not removed from UM buildings must be properly disposed of by the Contractor.

Suspect Contaminated Soil, Groundwater, or Unknown Material

During work activities, if suspect contaminated soil, groundwater, or other unknown material is encountered, the suspect material must be characterized to determine if special handling, or disposal protocol is required. Suspect contaminated soil may exhibit chemical or unusual odors, staining, unusual coloring, and/or contain man-made debris. Suspect contaminated groundwater may exhibit chemical or unusual odors, unusual coloring, and/or sheen.

SID-I

A/Es shall direct the Contractor that if suspect contaminated soil, groundwater, or other unknown material is encountered, they shall immediately cease all excavation, dewatering, transport, or disturbance of the suspect material, and they shall contact the U-M Project Manager and U-M OSEH (763-6973) immediately. Direct the Contractor not to resume activities until given direction by the U-M Project Manager.

Bulk Chemical Storage (tanks and drums)

Secondary containment is required for all chemical or oil bulk storage (drums or tanks) according to the MDEQ, Michigan Part 5 Rules and the Ann Arbor Sanitary Sewer Ordinance.

Some options for secondary containment include building a berm (curb), using double wall tanks or using spill pallets. The University considers it preferable to construct a permanent berm rather than using spill pallets.

The secondary containment must have the capacity to hold the volume of the largest container or 10% of the combined containers, whichever is larger. If the room has no floor drains, and if the required volume can be completely contained without escaping through cracks in the floor and pipe penetration, over thresholds, etc., then the room itself may be considered sufficient secondary containment. If the room is considered the secondary containment ensure there is a lip at the door so no liquids can exit the room in the event of a leak. Consider use of leak detection and alarm for the secondary containment, depending on hazard posed, and on likelihood that a leak will be observed within in reason period of time.

UNIVERSITY PROVIDED UTILITIES

Revised to indicate -50 compressed air dew point and that tunnel domestic hot water is no longer softened: 7-10-13 by D. Karle.

General

This section describes building utilities associated with U-M facilities.

Related Sections

Special Building Areas:

[SBA-H Tunnels](#)

U-M Design Guideline Technical Sections:

[15680 – Chilled Water Systems](#)

[15681 – Water Chillers](#)

Utility Distribution Overview

The University distributes electricity to the Central, Medical, and North Campuses and parts of the Athletic/ South Campuses.

Central Campus Utilities provided by the University's Central Power Plant include:

- Electricity
- Low pressure Steam (minimum of 6 psig)
- Medium pressure steam (60 psig, 350°F)
- Steam Condensate
- Compressed Air (90 psig, maximum of minus (-) 50°F pressure dewpoint)
- Domestic hot water (50 psig, 125°F, un-softened)

Pressures specified are at the utility building entrance.

In parts of the Athletic and South Campus, medium pressure (60 psig) steam with condensate return is provided from the University's Hoover Street Power Plant.

Other facilities may have regional or local steam systems capable of providing adequate capacities. Steam pressures may vary for these systems. Where these capacities exist, the proposed facility shall utilize them. Coordinate facility loads and intent with the U-M Project Coordinator. Utilities and Plant Engineering, through the Project Coordinator, will determine and provide the locations and capacities of existing systems.

University Provided Utilities Applications

Central Campus Steam

Low pressure steam should be used for building heating and humidification loads and for some absorption chiller cooling, because of the economy of generation and cogeneration in the Central Power Plant. Refer to Design Guideline 15680 and consult with U-M Project Coordinator before deciding on chiller type (absorption or electric).

Because of power plant economy, Central Campus Medium Pressure (60 psig) steam use is generally limited to the following applications:

- For critical buildings such as research labs and medical clinics, where sufficient 60 psig steam capacity is available, 60 psig steam via a pressure regulating valve should be used to provide redundancy to the building low pressure steam supply during interruptions.
- Special equipment, such as sterilizers.
- Multi-zoned application of “clean steam” humidifiers. “Clean steam” is defined as the steam generated from campus steam via a heat exchanger, using high purity water for makeup. Single zone clean steam shall be generated from 6 psig steam, but where multiple and separately controlled building zones must be fed from a single steam generator, 60 psig steam may be used.

60 psig steam shall not be used to boost existing nominal 6 psig steam pressure to higher pressures.

Steam Condensate

Central Campus condensate from low pressure and medium pressure steam shall be vented to atmosphere and pumped to the campus distribution system at minimum 30 psig pump pressure. South/ Athletic Campus condensate shall be similarly returned to the Hoover Boiler Plant.

Domestic Hot Water – Central Campus

New domestic hot water (DHW) connections on Central Campus should not make use of the central campus domestic hot water return (DHWR) system. Provide DHWR and return water re-heating system internal to the building, typically using low pressure steam and a shell and tube heat exchanger. Refer to Special Building Areas SBA-H Tunnels. Provide RPZ backflow preventer on DHW as it enters the building.

Chilled Water - Regional Plants

Chilled water from regional chilled water plants is available at some locations on North Campus and Central Campus. Where it is available, it should be utilized. A connection fee/ Capacity Reserve Charge is required. Contact the U-M Utilities and Plant Engineering Department through the Project Design Coordinator for direction. Refer to Design Guideline Sections 15680 and 15681.

Metering

The following utilities shall be metered in accordance with methods and means specified in other sections of the Design Guidelines:

- Electricity
- Central Campus Steam Condensate
- Steam, where humidification loads are greater than 500 pounds of steam per hour.
- Chilled water from regional plants – flow and BTU metering.

Where a regional chilled plant is part of a facility, metering or sub-metering shall be provided to measure the utilities consumed by the plant separately from the building metering.

Domestic Cold Water, cooling tower make-up water and cooling tower blow down, and irrigation water shall be metered separately in accordance with the City of Ann Arbor standards.

Domestic Hot Water (from Central Campus system) does not require metering as it enters the building.

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SUSTAINABLE DESIGN AND LEED® REQUIREMENTS

Introduction

The University of Michigan is committed to environmental stewardship and promotes implementation of sustainable design concepts. Many of these concepts are incorporated directly into various sections of the U-M Design Guidelines and Master Specifications. This section addresses additional requirements and resources with respect to sustainable design and LEED requirements.

Related Sections

U-M Design Guidelines:

[SID-B - Owner's Project Requirements and Basis of Design Documents](#)

U-M Master Specifications:

[015719 - Construction Air Quality](#)

[017420-Construction and Demolition Waste Tracking](#)

Related Documents:

[Building/Project Sustainability Summary](#)

[U-M LEED Project Registration Procedure](#)

[U-M Baseline LEED Checklist](#)

[U-M Post-Occupancy Thermal Comfort Survey](#)

[U-M Post-Occupancy Thermal Comfort Corrective Action Plan](#)

[U-M Refrigerant Calculation Table](#)

[U-M Comprehensive Transportation Management Plan](#)

[U-M OS1 Green Cleaning Program](#)

Reference Documents:

USGBC, "LEED® Reference Guide for Green Building Design and Construction"

USGBC, "LEED® Reference Guide for Building Design and Construction - Healthcare"

Sustainable Design Requirements

All Projects

Prior to beginning Schematic Design, clarify the design objectives with respect to sustainable design, in conjunction with the U-M Design Manager. It is the University's expectation that sustainability be a consideration for all projects.

U-M Master Specification [015719 - Construction Air Quality](#) shall be included in the contract documents and edited to be project specific. This specification provides requirements for construction air quality including requirements for bio-diesel fuel and exhaust after-treatment devices on construction equipment. It is also intended to include

those items required by the LEED IEQ credit pertaining to construction indoor air quality management.

U-M Master Specification [017420-Construction and Demolition Waste Tracking](#) shall be included in the contract documents. This specification documents the disposal of waste through use of the U-M Waste Tracking Report. This specification shall not replace construction waste management specification sections and shall not be edited by the A/E.

Document all sustainability design concepts in the project OPR/BOD (Owner's Project Requirements/Basis of Design) document. [SID-B - Owner's Project Requirements and Basis of Design Documents](#) provides a complete description of OPR/BOD requirements.

Upon completion of the Construction Documents phase, use the EPA website to determine if the project is eligible for Designed to Earn ENERGY STAR. A/E to process all required paper work should the project be eligible.

Projects Requiring Regental Approval

At the end of Schematic Design (SD) phase, assist the Design Manager with completing a [Building/Project Sustainability Summary](#) for posting on the AEC website. The Building/Project Sustainability Summary is to be updated at each design phase.

LEED Requirements

New Buildings and Additions over \$10M construction cost (new construction only)

All new buildings and additions with an estimated construction budget greater than \$10 million shall be designed to achieve a minimum of Leadership in Energy and Environmental Design (LEED) Silver certification using the appropriate rating system. Certification shall be obtained from the Green Building Certification Institute, Inc. (GBCI®).

In rare cases, projects may be exempt based on special building considerations:

- (a) Exceptions will be granted rarely and based on unusual building requirements driven by programmatic needs, such as specialized HVAC system requirements, specialized laboratories or high performance computing facilities with extreme energy requirements, and for specialty buildings outside the realm of the LEED rating systems.
- (b) Requests for exemption must be justified in writing, reviewed by the Associate Vice President for Facilities and Operations, and approved by the U-M Sustainability Executive Council.

All projects pursuing LEED certification will be registered with LEED Online by the U-M AEC Sustainability Coordinator; from that point on the A/E's designated LEED Project Manager will be responsible for assigning and managing the attempted credits within LEED Online. See the [U-M LEED Project Registration Procedure](#) for complete details.

All projects pursuing LEED certification shall utilize the following checklist and communication process, in addition to other processes required for certification:

- (a) At the conclusion of schematic design, develop a preliminary LEED Checklist utilizing the most current LEED Reference Guide for the appropriate rating system, including Addenda.
- (b) The checklist should identify all items for which credit can be achieved, items for which credit is under consideration, and items for which no credit can be achieved.
- (c) The [U-M Baseline LEED Checklist](#) outlines the credits that are likely achievable by projects pursuing LEED certification, based on past projects at the University. Carefully review the baseline checklist and consult with the U-M AEC Sustainability Coordinator before electing not to pursue any credit indicated as likely achievable.
- (d) For items "under consideration", clarify steps required for this review and analysis, potential options, and potential cost and benefit. The U-M Design Manager will assist in refining this list and provide direction on further action as design progresses to DD and CD phases.
- (e) At the conclusion of DD phase, update the LEED Checklist. A clear direction should be established for "under consideration" items. Items should be included in scope, deleted from consideration, or included as bid alternates.
- (f) At the conclusion of CD phase, update the LEED Checklist. The updated checklist should include any additions and/or subtractions to the project scope that may have occurred during design development and affect the total score anticipated at the conclusion of DD.
- (g) After GBCI® completes its review of the LEED application, the LEED Project Manager shall conference with the project team and the U-M AEC Sustainability Team and present all technical advice received from the GBCI® reviewers. Describe strategies to respond to points denied or information forms not approved. Conduct such conferences after every LEED review phase.
- (h) At the completion of the construction phase, update the LEED Checklist. The updated checklist should include any additions and/or subtractions to the project scope that may have occurred during construction and affect the total score anticipated at the conclusion of CD.

The [U-M Post-Occupancy Thermal Comfort Survey](#) and the [U-M Post-Occupancy Thermal Comfort Corrective Action Plan](#) are to be used when pursuing LEED-NC credit for thermal comfort verification. For projects pursuing this LEED-NC credit, this survey will be administered by the University of Michigan utilizing an internal procedure that complies with the credit requirements specified in USGBC's "LEED® Reference Guide for Green Building Design and Construction".

Existing LEED Certified Buildings

Projects within LEED certified buildings shall be implemented so as not to jeopardize sustainable design and the LEED certification. Click [here](#) for a complete list of LEED certified buildings.

Additional Resources

The [U-M Refrigerant Calculation Table](#) is a tool that is available for use during the selection of refrigerants and heating, ventilating, air conditioning and refrigeration (HVAC&R) equipment. For projects pursuing LEED-NC certification, this table provides guidance in determining HVAC&R compliance with LEED-NC 2009 EAc4 Enhanced Refrigerant Management.

The [U-M Comprehensive Transportation Management Plan](#) demonstrates a quantifiable reduction in personal vehicle usage through campus wide alternative transportation programs. Consider the use of this when pursuing Exemplary Performance for LEED-NC Alternative Transportation credits. A complete description of this credit is located in USGBC's "LEED® Reference Guide for Green Building Design and Construction".

The [U-M OS1 Green Cleaning Program](#) describes the comprehensive cleaning system used by U-M Plant Building and Grounds Services. For projects pursuing LEED-NC, consider the use of this document when seeking Innovation in Design credit for Green Housekeeping.

Projects involving demolition are encouraged to divert waste from landfills by taking advantage of recycling opportunities currently available through outside companies. Below is a list of recycling programs that AEC is aware of. Contact the AEC Sustainability Coordinator with questions.

Vinyl Composite Tile

- Armstrong World Industries, Inc.

Acoustic Ceiling Tile

- Armstrong World Industries, Inc.

Carpet

- Calvert's Roll-Off Containers, Inc. (operated by Recycle Ann Arbor)
- Great Lakes Recycling - GLR

Carpet Padding

- Recycle Ann Arbor-Calvert's
- Great Lakes Recycling



OWNER'S REVIEW

General

Scope

The A/E's design documents will undergo University of Michigan (Owner) reviews at the conclusion of its major stages of design (generally at the end of SD, DD, and CD phases). The Owner's reviewers may include (but are not limited to) the U-M Project Director, U-M Design Manager, U-M Project Manager, external construction manager, UM Planner's Office, U-M user groups, U-M Dept. of Public Safety and Security, U-M OSEH, U-M Architecture and Engineering, U-M Interior Design, U-M ADA Coordinator, U-M Commissioning and Plan Review, U-M Code Inspection, U-M Utilities and Plant Engineering, U-M Plant Operations Shops, U-M Key Office, U-M Building Services, U-M Zone Maintenance, U-M Grounds and Waste Management, U-M Parking and Transportation, U-M ITCS (telecommunications), U-M Risk Management, and Factory Mutual. The Owner's Representative (Design Manager) will coordinate the Owner's review activities.

An Owner's review is a comprehensive examination of a project's design documents to evaluate if the design generally meets the Owner's requirements. The Owner's reviews shall not serve as the A/E's design, drafting, or coordination checks. The documents shall be coordinated and checked by the A/E before being submitted to the University.

Related Sections

U-M Design Guidelines:

[Design Deliverables](#)

U-M Design Guidelines Special Instructions to Designers:

[SID-B - Owner's Project Requirements \(OPR\) and Basis of Design \(BOD\)](#)

[SID-D – Energy and Water Conservation](#)

Execution

When the design documents are submitted to the University, the submittal shall include a Design Deliverables checklist that is marked to indicate the completeness of the design documents. The submittal shall also include an updated OPR, BOD and an updated Energy Impact Statement.

When the design documents are received, the Design Manager will distribute them for review. Comments received by the Design Manager will be assigned action codes and sent to the A/E for resolution. On large or complex projects, the Design Manager may hold meetings with the A/E and reviewers to discuss the comments before action codes are assigned.

The A/E shall:

- Incorporate all comments coded “A” (approved), or contest the comment in writing to the Design Manager.
- Provide the Design Manager with a written response to each comment coded “R” (A/E to review and reply) or “O” (other action required). Each response shall describe how the associated comment is being resolved.
- Request clarification of any comment that is not fully understood. A response similar to “Comment not understood” is unacceptable.
- Discuss with the Design Manager any comment that will significantly affect the project’s schedule or budget and document these in a written summary of the review.

The Owner’s reviewers will spot check the A/E responses to verify that their review comments were properly understood. The reviewers will then spot check the next revision of the design documents to verify that their comments were resolved. Comments that were ignored or not adequately resolved may be resubmitted as often as necessary until they are completely and acceptably resolved.

While the Owner’s reviewers strive to provide appropriate comments as early in the design as possible, specifics of the design often do not appear in sufficient detail for complete comments until the final review. Therefore, the lack of comments on a vague or incomplete aspect of the design during the earlier reviews shall not be construed as Owner approval of any iteration of the design.

SPECIAL REQUIREMENTS

Ladders, Catwalks and Platforms

Ladders, stairs, catwalks and platforms should be provided to areas where access is required for inspection or maintenance. Of particular importance is access to fans, balancing and flow control dampers, steam traps, sanitary clean-outs, and sensors located high above suspended ceilings. Do not rely on walking across ductwork to reach these components.

Catwalks and/or platforms should be provided in accessible shafts and plenums for inspection, maintenance and/or future modifications.

In mechanical rooms arrange ceiling suspended fans with clearance below to allow access from a jack stand.

Loading Docks

Provide space for compactors and utility carts. The specific type of refuse container or compactor must be reviewed with the Grounds Department through the University Project Coordinator early in the design process. Must have access for the large 34 cubic yard trucks to service the containers.

Provide electrical outlets at the loading dock for the compactors and for other general purpose needs.

Pipe Insulation

Cold water pipes are to be insulated to prevent condensation of water vapor in the adjacent air. Specifically call out on the construction documents the equipment in the cold water lines which also needs insulating - this includes fitting as well as pumps, tanks, strainers, valves, unions, etc.

Roof Penetrations

In any design where a roof penetration will be made, the construction documents shall clearly indicate that the cutting and patching (sealing) of the roof must be made by a roofing contractor. The Maintenance Roofing Department must be informed at least 24 hours in advance of the penetration.

Air System Design Layout

Careful consideration must be given to the feasibility of obtaining accurate measurements for all aspects of the system's performance:

- Provide manufacturer required straight inlet and discharge duct lengths at all fans, air flow stations, static pressure sensor, air blenders, air terminal boxes, humidifiers, etc.

SID-M

- Do not locate sub-main or branch takeoffs within 7.5 equivalent duct diameters of the fan outlet.
- Lay out ductwork and dampers so that accurate flow measurements can be made at all mains, sub-mains and branches. This normally means 7.5 diameters of straight duct. Show dimensions of straight runs to assure acceptable measurement accuracy.
- Do not allow the use of splitter dampers.
- For constant volume systems, show balancing dampers on the drawings in all sub-mains and branches and specify their type using ASHRAE Standard 111-1988 as a guide.
- Make provision in the layout for measuring the amount of outdoor air at both minimum and maximum outdoor air damper conditions.
- Flow measuring stations with cfm gauges are preferred for all fans larger than 5000 cfm.
- Include system effects in total pressure calculations.

Water System Design Layout

Show all balancing stations and isolation/shut-off valves on the drawings. Typical details may be used for equipment such as pumps, coils and fin tube, sub-mains and branch line balancing stations and isolation/shut-off valves must be shown on either the floor plans or a riser diagram.

Details and plans must clearly show locations of balancing stations so that accurate flow measurements can be made at all mains, sub-mains and branches. Show dimensions of straight runs to assure acceptable measurement accuracy.

Venturis or pitot tube type measuring devices are preferred for all piping 4" and larger. Note that some venturi manufacturers require less straight piping up and downstream than do pitot tube manufacturers.

Gpm gauges are preferred for all pumps larger than 200 gpm.

Drawing Symbols

The A/E shall show the location of all equipment on the drawings using accepted symbols shown in the Legend. Do not rely on notes to instruct the Contractor to include in the project. Examples of equipment to be shown at each and every intended location are: flow control and isolation valves, all types of dampers, turning vanes, access doors, clean-outs, etc.

Suspension of Materials Above Ceilings

The A/E shall design the means of suspending systems from the slab above, and allow space for the hangers. Piping, ductwork and equipment shall have independent support systems (i.e. piping shall not be supported from ductwork supports, etc.) Do not suspend anything (including electrical

conduit) from ductwork. Show trapeze hangers on the drawings, and provide additional details as necessary to convey the A/Es intent to the Contractor. Verify that sufficient space exists above existing suspended ceilings for the design.

In existing buildings new piping, ductwork and equipment shall not be supported from existing hangers and/or existing supplementary steel without A/E verification of existing component conditions and loading capacities.

Substitutions

The A/E should review the included approved manufacturers list provided in these Guidelines, and follow in the preparation of the specification. If the A/E believes other manufacturers should be considered they must discuss this issue with the University Project Coordinator prior to release of the construction documents. Once the documents are out for bid, the University will not allow a product by a manufacturer not in the specification. Our position should be made clear in the documents.

Fire Protection

The A/E shall provide a completed fire protection design on the construction documents. Include pipe routing and sizes. Do not rely on the fire protection engineer supporting the contractor to design the system.

Renovation Projects

Visible architectural features to match existing. Mechanical systems shall be compatible with existing unless a more energy prudent design is appropriate and/or existing systems violate requirements of applicable codes. Electrical systems to be compatible with existing.

Major Building Renovations

Provide steam to hot water converters for temporary heat during construction phase.

Ventilation

Select minimum ventilation per ASHRAE Standard 62-89, except in no case less than 15 cfm/person of outdoor air.

Coil Freeze Protection

Coil freeze-up is a frequent problem because of the large component of outside air required at many of our facilities. The design of the air handler must address this problem specifically, and include a mixing plenum design which provides good mixing, air blenders, pre-heat coils, internal face and by-pass dampers or external face and by-pass dampers. Air handling units with integral face and bypass dampers the freeze stat shall be located a minimum of 36" down stream of the dampers.

Prepackaged Spec quality units need to be closely analyzed by the A/E, and modified internally or externally as necessary to provide the necessary freeze protection.

Exterior Equipment/Elements

The University is sensitive to building appearances, and as such has an Exterior Elements Design Review Committee. A/Es designing a new building, or renovating an existing building which includes exterior elements shall obtain this Committee's approval before finalizing the design. Equipment selection shall consider concealment, aesthetics and blending in with adjacent structures.

Interruption of Services

Specify in the Design Documents that both the Utilities and Telecommunications Departments are to be notified before any digging or transportation of large/heavy equipment occurs on any of the University campuses.

Fire Dampers

The State Fire Marshal has final authority on the locations requiring fire dampers. Essentially the requirements and allowable exceptions specified in the BOCA Mechanical Code (1987) are followed. The Assistant Director of Safety, Robert Patrick (763-3434) represents the University in this matter, and should be consulted through the University Project Coordinator early in the design phase whenever the A/E requires an interpretation of the applicable codes.

Separation from Building Services

Waste and vent piping serving laboratories, research areas, or handling acid shall not be connected to the building general sanitary system.

Room Pressurization Control

Numerous rooms exist throughout the University which must maintain pressure (either positive or negative) with respect to adjacent corridors and rooms. The control system must be reliable.

Cleaning - Refuse Removal

Must have access for the large 34 cubic yard compaction trucks to service the container.

Type of refuse container or compactor must be reviewed with the Grounds Department personnel early in the design process.

A fireproof space must be planned for storage of recyclable materials.

Custodial Closets

Minimum of 1 on each floor if it is a small building. However, 2 on each floor on opposite wings is preferable. Custodial closets should not share spaces that contain mechanical equipment, exits to roof, electrical panels to which other personnel or building occupants must have access. These facilities must be capable of having security for equipment which is costly. Space for 1 month supply storage must also be available in the building. See attached diagram of central housekeeping storage area.

See Standard Details for preferred room layouts.

Natural Gas Shut Off Valves for Laboratories

Master Gas Shut-Off Valves

A readily accessible manual shut-off valve is required at the building gas supply connection. Applicable requirements of Michigan School Fire Safety Rules 29.301 through 29.321, effective July, 1989, impose NFPA 101-85 with modifications. NFPA 30, 45, 54, 58 and 90A are referenced in NFPA 101. None of these applicable codes or standards require this valve.

Previous Fire Safety Rules 29.1 - 29.298, which included a requirement for a laboratory master gas shut-off valve, have been rescinded.

While there is no code requirement for a master gas shut-off valve serving an individual laboratory The University of Michigan prefers one for any lab which has more than two gas outlets.

Point of Use Gas Shut Off Valves

NFPA 45 and 54 require readily accessible manual shut-off valves (e.g. bench top turret valves) within 6 feet of equipment being served (e.g. bunsen burners). NFPA 54 also states that the shut-off valves may not be located above ceilings.

Packaged Equipment

Specify all packaged equipment components (e.g., valves, gauges, thermometers) so that they use the same manufacturers, features and quality as the same components provided elsewhere in the project. For example, a heat exchanger package specification should either contain the same spec for valves as Section 15050 or should refer to 15050 as the requirement for all valves provided with the heat exchanger package. It is not necessary that the heat exchanger valves be the same manufacturer as the rest of the project, just that they meet the same specification.

Room Numbering

Room numbering on contract documents must conform to the Facilities Planning and Design Key Plan Group conventions. Coordinate this through the University Project Coordinator.

Mechanical Room Floors

All mechanical room floors and curbs which are not slabs on grade shall be waterproofed to prevent leakage into occupied space below.

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RECYCLING MATERIALS

Introduction

This section addresses recycling and other diversion methods for materials that may be encountered in construction or demolition projects. This document provides guidance for identifying materials which are recyclable or otherwise able to be diverted and available methods for proper disposal.

Related Sections

U-M Design Guidelines:

[SID-K – Sustainable Design and LEED® Requirements](#)

U-M Master Specifications:

[028110 - Regulated Construction Waste Remediation](#)

[028213 – Asbestos Remediation](#)

[028214 – Asbestos Remediation – Floor Tile and Mastic](#)

[028215 – Asbestos Remediation – Roofing Material](#)

[028300 – Lead Remediation](#)

[028333 – Lead Remediation – Renovation, Repair and Painting in Child-Occupied Facilities and Target Housing](#)

[028400 - PCB Remediation](#)

Demolition Requirements

All Projects

Efficient construction and demolition waste management is encouraged on all construction, renovation and demolition projects. Coordinate and review materials with the U-M Design Manager and the U-M Project Manager to identify adequate on-site facilities for separating and storing materials to be recycled and salvaged.

Definitions

Construction and Demolition Debris: Building and site improvement materials resulting from construction or demolition operations.

Disposal: Removal off-site of demolition and construction debris and subsequent sale, recycling, reuse, or deposit in a permitted solid waste landfill.

Hazardous Waste: Waste which contains asbestos, lead-based paint or oil and other corrosive or toxic materials.

Recycle: Diversion of demolition or construction debris from the landfill for reuse.

Salvage: Recovery of demolition or construction debris and subsequent sale or reuse in another facility.

Onsite Reuse: Recovery of demolition or construction debris and subsequent incorporation into the Work.

Potentially Hazardous: Materials which are painted, stained, glazed, treated, odorous or contaminated from a chemical spill.

Primary Constituents of Construction and Demolition Debris with Potential for Recycling

Asphalt Pavement:

Asphalt can be recycled and can be transported to an asphalt-recycling facility.

Asphalt Shingles:

Asphalt shingles can be recycled in Michigan so long as they do not contain asbestos. Contractor and the project client shall determine if recycling is cost effective. Currently the nearest receiving facilities are in Lansing, Flint and Southfield.

Carpet:

Carpet and carpet padding may be recycled without restriction. Adhesives and tack strips need to be removed upon removal.

Ceiling Tile:

Major ceiling tile manufacturers offer no-cost pickup and recycling of many types of clean, unpainted, uncontaminated tile. Foil backed tile cannot currently be recycled in this area. To be recycled, tile must be tested for asbestos and must be located in an area where there is no above-ceiling asbestos. On-site requirements include a location for storing palletized and shrink-wrapped tile for pickup by the manufacturer. Specific requirements can be obtained by contacting the two manufactures that offer the service in this area; Armstrong and USG.

Concrete:

Clean (i.e. unpainted, uncoated, uncontaminated) concrete may be recycled or reused. Reuse options to be reviewed and coordinated with U-M Design Manager. Concrete that is painted, glazed, stained, treated, odorous or otherwise contaminated from a chemical spill must be tested by OSEH to determine disposal and recycling options.

Flooring:

Flooring may be recycled provided it is not painted, stained or contaminated from a chemical spill. Tile which is glazed/fired must be tested by OSEH.

Gypsum Board:

Clean gypsum can be diverted to recycling and reuse outlets by performing the following actions:

- Deposit clean gypsum scrap into source separated containers and protect from weather.
- Remove edge trim and sort with other materials.
- Remove and dispose of fasteners or other contaminants.

Materials which may be contaminated (i.e. painted, stained, or otherwise treated) shall be tested by OSEH. If paint has been treated and found to contain lead, the material must be further tested using Toxicity Characteristic Leaching Procedure (TCLP) to determine if it is a hazardous waste. Any attempt to clean or separate contaminated from uncontaminated material must be done with OSEH approval.

Masonry:

Masonry including, brick, block, and stone are recyclable provided they are not contaminated (i.e. painted, sealed, glazed). Materials which may be contaminated shall be tested by OSEH to determine appropriate disposal or recycling options.

Metals:

Metals including rebar, pipe, copper, aluminum, steel, lead and other metals may be recycled provided they are not hazardous. Materials which are painted, coated, or contaminated must be tested by OSEH prior to attempts to clean or separate contaminated from uncontaminated material. Clean materials may be reused on-site or taken off-site to recycle or to a donation center. Review and coordinate the reuse of materials with U-M Design Manager and verify whether MDEQ permits are required for proposed material reuse.

Packaging Material:

Boxboard, corrugated cardboard, and mixed paper may be recycled without restriction. When possible, require suppliers to remove pallets from Project site.

Plaster:

Plaster is recyclable when free of asbestos or lead paint. Old plaster is essentially concrete material and can be recycled as such. Lime plaster is also recyclable in most communities.

Wood:

Unpainted, untreated, and unstained wood, including scrap wood and untreated wood sawdust can be recycled, or can be used on site with OSEH approval. Materials which may be contaminated (i.e. painted, stained, or otherwise treated) shall be tested by OSEH. Any attempt to clean or separate contaminated from uncontaminated material must be done with OSEH approval.

Yard Waste:

Site-clearing wastes such as brush, branches and trees may be chipped on site. Contact Grounds Services to determine if resulting mulch is able to be composted on U-M property.

Vinyl Siding:

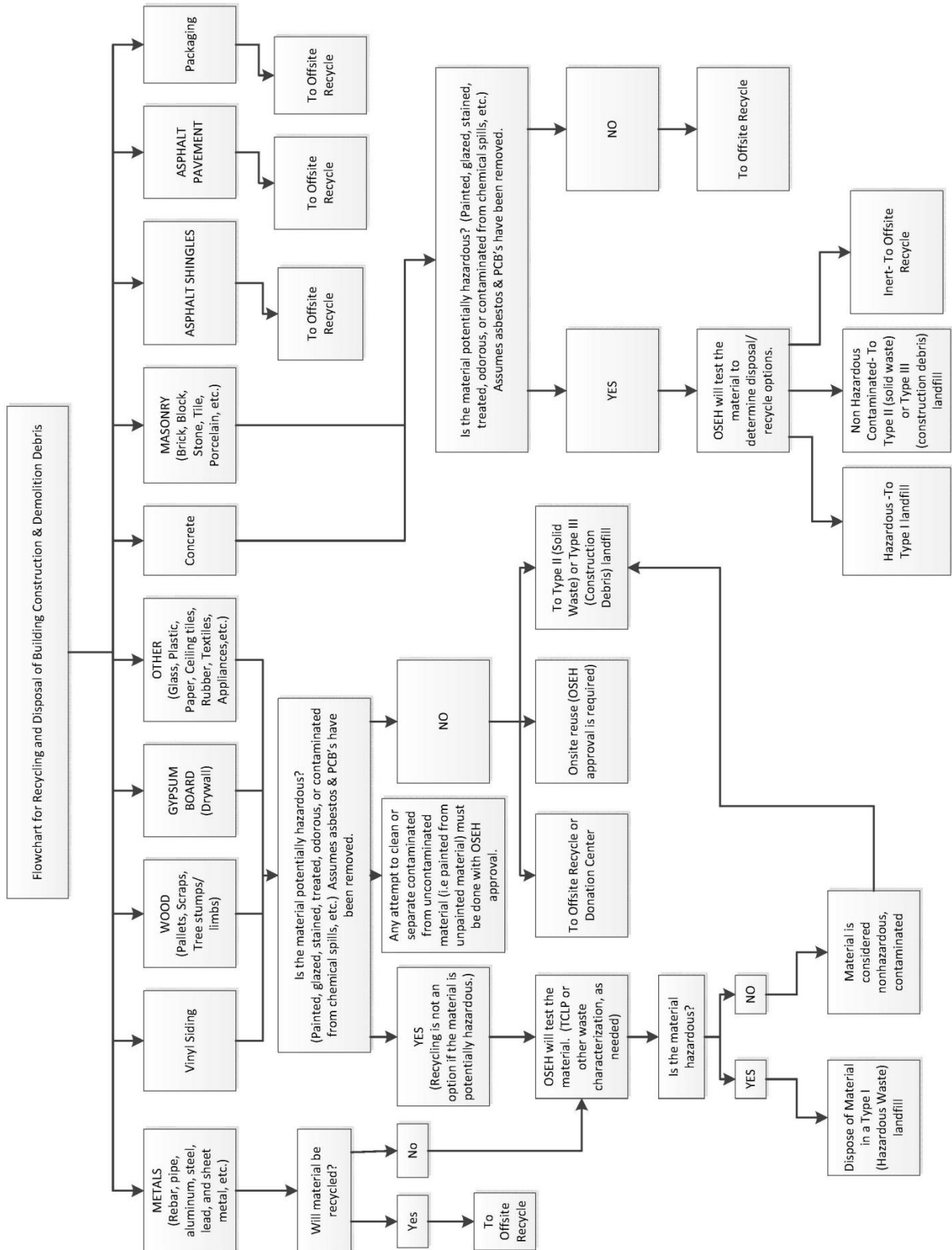
Clean vinyl siding may be recycled without restriction. If siding has been painted or otherwise treated, it must be tested by OSEH. Any attempt to clean or separate contaminated from uncontaminated material must be done with OSEH approval.

Other:

Other potentially recyclable materials commonly resulting from construction and demolition projects include glass, plastic, paper, rubber, textiles and appliances. Assuming asbestos and PCB's have been removed or are otherwise not present, these materials are recyclable if not potentially hazardous due to any chemical treatment or spills. If there is reason to believe these materials may be contaminated, OSEH should be contacted.

Flowchart for Recycling and Disposal of Building Construction & Demolition Debris

The attached Flowchart for Recycling and Disposal of Building Construction & Demolition Debris distinguishes what demolition and construction waste materials can be recycled offsite, reused onsite or sent to a type I landfill.





PROJECT ESTIMATES

General

The procedures described in this section pertain to University of Michigan construction projects with a construction cost of \$500,000 or more. Though it is not required, it is suggested that the consultant or contractor follow these procedures on the smaller project, as well.

Professionals performing estimating services for Architecture, Engineering and Construction (AEC) are mandated to use the following standard estimating formats.

- *Program Phase:* (Uniformat II) - [Estimate Uniformat2.xlsx](#)
- *Schematic Design through Construction Document Phases:* (CSI-2012) - [Estimate CSI 2012.xlsx](#)
- NOTE: CSI 2012 = Construction Specifications Institute, April 2012 “*Masterformat*” Specification Categorization

Professionals may complete these templates as provided, optionally using additional “tabs” for more specific levels of detail. NOTE: The Level 1 Summaries are entirely populated with data from the Level 2 Breakdowns. The professional estimator may opt to use proprietary software, provided that the “CSI and Uniformat 2 Level 1 Summaries” and “CSI and Uniformat 2 Level 2 Breakdowns” are formatted to accurately match the AEC templates. In both type estimates, the respective detail sheets relating to the Level 2 Breakdown and thus, the Level 1 Summary, must accompany the estimate and relate specifically to the CSI Masterformat categorizations of which they are intended to be a part. No modification or deviations from the Level 1 template will be allowed. Any advantageous or project-specific changes to the Level 2 template must be submitted to, in writing, and be approved by the AEC Design Manager or Construction Manager, prior to the creation of the estimate.

These templates have been created as “standards” for University of Michigan Project Cost estimate. Compliance with the intent of these templates are a mandate, not an option.

UM Hospitals and Health Centers (UMHHC) projects are exempt from these requirements and shall utilize the standard estimating format template found on the UMHHC Facilities Planning and Development web page.

Execution

Cover Sheet

Every estimate document shall be accompanied by a Cover Sheet or Sheets which include the following information:

- University of Michigan Building Name; Project Name; Brief Project Scope Description; University Project Number
- A List of Documents showing all documents used or referenced as the basis of the estimate. These documents shall include all the following accompanied by their listed dates:
 - Plans

- Specifications
- Sketches
- Gross Area Summaries
- Site Areas
- Addendums
- Meeting Notes
- Schedules, etc.
- A List of Allowances showing either Lump Sum or Unit Price allowances included within the “*FIXED LIMIT OF CONSTRUCTION COST*”.
- Construction start and completion dates upon which the estimate is based.
- A detailed basis used for escalation calculations, i.e., “midpoint of construction”.
- A List of Exclusions from the “*FIXED LIMIT OF CONSTRUCTION COST*”, examples of which might be
 - Abatement
 - HazMat Removal
 - Utility Services Upgrades (not yet defined)
 - Connection Fees
 - Permit Fees
 - Owner-supplied Equipment
 - Moveable Furniture
 - Testing Fees, etc.
- A List of Clarifications relating to:
 - Incomplete Documents
 - Unusual Circumstances
 - Mitigation of Obvious Document Errors or Inconsistencies
 - Specific Exclusions
 - Allowances, etc.

Templates: Line-Specific Information

CSI & Uniformat 2 **Level 1 Summaries:**

The first portion of the Summary, “*CONSTRUCTION TRADES SUBTOTAL*”, [Sections A-G, Uniformat II and 00 00 00 – 33 00 00, CSI 2012] should account for all known direct labor and materials costs based upon applicable local market conditions at the time of the estimate. As noted on the last line of the Level 1 Summary, “*This template includes pre-set formulas, however, estimating professionals are ultimately responsible for the accuracy of the information submitted.*”

The second portion of the Summary, “*TOTAL CONTINGENCY; ESCALATION &; GENERAL CONDITIONS COSTS*”, should account for Design Contingency, Escalation, General Conditions, Management Fees, Indirect Costs and Profit. These costs will totaled separately and added to the “*CONSTRUCTION TRADES SUBTOTAL*”, to form the “*FIXED LIMIT OF CONSTRUCTION COST*”. Separate categories for “*ALLOWANCES*” and “*ALTERNATES*” will be listed and totaled separately. If applicable to the project, these optional costs may then be added to the “*FIXED LIMIT OF CONSTRUCTION COST*” to form the “*TOTAL UPPER LIMIT OF G.M.P.*”.

CSI & Unifomat 2 **Level 2 Breakdowns:**

The first eight rows of the Breakdown comprise the input areas of strategic project descriptors, i.e., Project Name, Gross Building and Site areas and Relevant Project Timeline Dates, for use in calculations throughout this worksheet. This section populates the parallel cells on the Level 1 Summary.

For the CSI 2012 estimate, the second section of note is category number “01 00 00 – *GENERAL REQUIREMENTS*”. The values of the categories within this breakdown parallel the cost inputs named in the section entitled “*TOTAL CONTINGENCY; ESCALATION & GENERAL CONDITIONS COSTS*”, below the “*CONSTRUCTION TRADES SUBTOTAL*”. The estimator will populate both of these sections at their own discretion, defining the cost components to produce an accurate total cost for these items. The University expects that estimator will utilize both quantifiable values for specific items or, amounts equaling a historical percentage of the “*CONSTRUCTION TRADES SUBTOTAL*”. The estimator will assure that the aggregate costs represented in these two categories do not overlap and represent an accurate portrayal of the expected “01 00 00 – *GENERAL REQUIREMENTS*” costs. This is the same expectation for both General Contract and Construction Management projects.

For the Unifomat 2 estimate, the “*GENERAL CONDITIONS COSTS*” will be carried as an historical percentage of the “*CONSTRUCTION TRADES SUBTOTAL*”.

The second section of this Breakdown comprises the categorical summations of the quantities and costs as described in the CSI 2012 *Masterformat* Numbers and Titles. Each line has only two “input” cells, the “*QUANTITY*” and the “*TOTAL DOLLARS*”, both of which comprise the automatically-calculated “*AVG PRICE*”. Specifically named for each *Masterformat* category, is the “*UNIT*” of measure in which the estimator will describe his “*QUANTITY*” input. [*Outside the right margin of the cost calculation data is a description of each abbreviated “UNIT” of measure*]

The third section of this Level 2 Breakdown comprises the source calculations for the difference between the “*CONSTRUCTION TRADES SUBTOTAL*” and the “*FIXED LIMIT OF CONSTRUCTION COST*”. The definitions of the line item descriptions contained therein follow.

- *Design Contingency* – A suitable allowance of cost, based on a “percentage” of the “*CONSTRUCTION TRADES SUBTOTAL*”, for items or options not yet fully-designed and which may be incorporated as the design progresses. Typical historical percentages are: Schematic Design +10%; Design Development +5%; Construction Document +0% to 1%, based on the completeness of the CD documents on which the estimate is based.
- *Escalation* – A suitable percentage of the “*CONSTRUCTION TRADES SUBTOTAL*”, based on generally-anticipated cost increases between the date of the estimate and the scheduled Midpoint of Construction. Escalation factors may include: anticipated rates of “Inflation” or local “Market Conditions” affecting the cost of construction. [*Category-specific, anticipated cost increases, due to factors like material or labor shortages, should be accounted for within each specific category number and be noted as such*]
- *Escalation Calculation*: Is defined by the formula: $((1 + \text{Annual Rate of Escalation})^{\frac{\text{Total Days from the estimate date to the midpoint of construction}}{365.25}} - 1)$. This calculation is a mandate, not an option.

- *Escalation Example:* 460 days @ 3% per year: $((1+.03) ^ (460/365.25))-1 = 3.79\%$. This is the University standard for the calculation of escalation for all projects.
- *CM or GC General Conditions:* These construction-support related costs are described in category number “01 00 00 – GENERAL REQUIREMENTS”. These costs may be based on a historical percentage at the Schematic Design phase, a combination of quantifiable costs and historical percentages at the Design Development Phase and completely-defined quantifiable costs at the Construction Document / Bid Phase.
- *CM/GC Personnel:* Cost for management staff, during the construction, as described in category number “01 00 00 – GENERAL REQUIREMENTS”. [This may include project managers, superintendents, project engineers and estimators]
- *CM Fee/GC Profit:* Construction Management Company Fee or General Contractor’s overhead and profit.
- *Pre-construction Services:* A fee for construction management support prior to commencement of construction. [This is not applicable to General Contractor project delivery]
- *CM Contingency:* An agreed-upon percentage of the “CONSTRUCTION TRADES SUBTOTAL” for mitigation of unforeseen conditions and other unanticipated costs that may occur during construction. [This is not applicable to General Contractor project delivery]
- *Related Construction Cost Allowances:* These costs are identifiable, essential Construction Cost items which may be paid directly by the University, be outside of the contract, or be added to the contract by the University. When these costs are carried as line items within the “CONSTRUCTION TRADES SUBTOTAL”, they should be identified as “Related Construction Costs” of the overall project budget. Beyond the Programming Phase these line items should be moved to “Related Construction Cost Allowances”, thus lowering the “FIXED LIMIT OF CONSTRUCTION COST”. Items in this category should be coordinated with the AEC Design Manager.
- Examples of *Related Construction Cost Allowances* are:
 - University Connection Fees
 - Utility Tie-in Costs and Fees
 - Sidewalk Closures
 - Project-specific Testing, etc.
- When these costs are carried as line items within the “CONSTRUCTION TRADES SUBTOTAL”, they should be identified as “Related Construction Costs” of the overall project budget. Beyond the Programming Phase these line items should be moved to “Related Construction Cost Allowances”, thus lowering the “FIXED LIMIT OF CONSTRUCTION COST”. Items in this category should be coordinated with the AEC Design Manager.
- *Alternates:* Are individual, independent “FIXED LIMIT OF CONSTRUCTION COSTS” for stipulated “Add” or “Deduct” construction items, based on the “CONSTRUCTION TRADES SUBTOTAL” for each alternate and the “TOTAL CONTINGENCY; ESCALATION & GENERAL CONDITIONS COSTS”, as included in the overall project “FIXED LIMIT OF CONSTRUCTION COST”.

The CSI 2012 and Unifomat 2 estimate formats are the standard for University of Michigan cost estimate of equal or greater value than \$500,000. No modifications to these formats shall be made without the express written approval of the Design Manager or Construction Manager.

SID-P-H: ESTIMATING GUIDELINES FOR UMHC FACILITIES

Related Sections

Basis Guideline: NA

For an explanation of the use of these guidelines, see [“Design Guidelines for UMHC Facilities”](#)

General

Professionals performing estimating services for UMHC are expected to use the estimating templates as follows:

- Investigations through Construction Document Phases – [CSI](#) (Construction Specification Institute) division template

In all cases the respective budget summary and detail sheets should be provided. Any proposed modification or deviations from these templates must be approved by the UMHC FPD Project Manager prior to the creation of the estimate.

Execution

A coversheet with the following information must also accompany all estimates:

- Project title, description and project number
- Reference to documents that are the basis for the estimate including applicable drawings, specifications, sketches, meeting notes, schedules etc.
- Construction schedule time frame upon which the estimate is based if a schedule is not referenced.
- Clarifications.
- List of exclusions including abatement/removal of hazardous materials, potentially required utility services upgrades that are yet undefined, connection fees, permit fees, owner supplied equipment, moveable furniture, testing fees, etc.

The first portion of the estimate (0-16 CSI format) should account for all known direct labor and materials costs based upon applicable local market conditions at the time of the estimate. Contingency factors, general conditions, management fees, escalation, profit and other indirect costs will be factored in after the direct cost is totaled. Provide a line-specific note for line items where cost is based on an allowance rather than an estimate.

Line Specific Information:

- *99031- CM/GC General Conditions* - Construction support related costs, including trailer, fencing, signage, computers, and printing etc, usually based on a percentage of construction cost. Note that this GC cost is typically itemized under Division 1 “General Requirements” and hence this line is left blank.
- *99042- Pre-construction Services* - A fee for construction management support prior to construction (not applicable to General Contractor project delivery). **Do not use unless directed by UM Proj. Manager.
- *99032- CM/GC Personnel* – Cost for management staff during the construction phase of the project. This may include project managers, superintendents, project engineers or estimators. Note that this CM/ GC cost is typically itemized under Division 1 “General Requirements” and hence this line is left blank.
- *99033- CM Fee/GC Profit* – Construction management or general contractor’s profit.

- *99050- Allowances* – Project cost items such as connection fees, sidewalk closure allowances, etc., that will be paid directly by the University, outside of the contract. As an option, these costs can be carried in the construction estimate during programming but should be transferred by the Design Manager into the Total Project Costs of the overall budget by the Schematic Design phase. Once the costs go to Total Project Costs, the fixed limit should be adjusted downward, as appropriate.
- *99090- Alternates* – Full cost for any add or deduct alternate construction items, including direct material and labor costs, plus all other indirect mark-up listed above.

The following costs are **NOT** to be included in the A/E's construction estimate but are rather to be included in the overall project estimate prepared by the UMH Design Manager:

- Contingencies of any kind, including Design Contingency, Construction Contingency or User Contingency.
- Escalation
- Fees paid directly by UMH including Abatement, Utility Service/Connection Fees, Air & Water Testing and Balancing, and Soil/Environmental Remediation.
- A/E or UMH/UM Fees
- Furnishings & Equipment including moveable Medical Equipment, Furniture, Signage and Computers.
- Telecommunication cabling and hardware furnished by UM ITCOM or MCIT.

For projects that require a higher than average contingency or require atypical A/E fees, the A/E is requested to summarize these costs under a coversheet separate from the construction estimate.

BUILDING ACCESS CONTROL

General

This section addresses minimum functional and technical requirements of the Building Access Control (BAC) system on the University of Michigan Ann Arbor Campus. Functional requirements apply to General Fund buildings. Technical requirements apply to all buildings connecting to the campus BAC system.

University of Michigan Hospitals and Health Centers (UMHHC) and University of Michigan Housing (UMH) maintain their own respective access control systems, standards and hardware. For UMHHC projects, contact UMHHC Facilities Planning and Development. For UMH projects, contact Design Manager.

Related Sections

U-M Design Guideline Sections:

[SID-F Codes and Regulatory Agencies](#)
[08710 Door Hardware](#)

U-M Master Specifications:

[08710 Door Hardware](#)
[16724 Security System General Requirements](#)
[16727 Access Control and Monitoring System](#)

U-M Standard Details:

16725 Series - Request from Design Manager

Definitions

Building Access Control (BAC): Campus central electronic system (existing), local building panels, distribution and hardware that controls and monitors access to a building and areas within a building based on one or more of the following types of doors:

- *Monitored:* Use of monitoring devices to detect forced door openings and door held conditions.
- *Electronically scheduled:* Use of a central time clock to electronically schedule the locking and unlocking of doors plus functions described for monitored doors.
- *Card reader:* Use of a code, card, or other method of authentication to unlock a door plus functions described for monitored and electronically scheduled doors.
- *Card reader with auto door operator:* Use of a push button to initiate a low energy operator that is interfaced with BAC functions described for monitored, electronically scheduled, and card reader doors.

Mechanical or battery operated digital security hardware: Stand alone mechanical locks that use keypads or other local methods of authentication to gain access to a secured area.

Surveillance systems: Surveillance systems shall include any Closed Circuit Television (CCTV) system installed for the purpose of viewing and/or recording video images for security or system troubleshooting purposes.

BAC: Minimal Functional Requirements

New buildings, additions and major renovations

Evaluate the physical and programmatic layout of the building as related to BAC locations and security requirements. Pay particular attention to egress paths through secured areas, interior connections to adjacent buildings, and control points that are required by code to connect to the building fire alarm system.

Exterior Doors

Provide exterior doors that connect to the campus BAC system and meet the following minimum requirements:

- General (all doors):
 - Provide key cylinder and hardware capable of mechanical access.
 - Provide hardware that allows manually-actuated egress requiring only a single operation at all times.
- Card reader with auto door operator: At least one access point for authorized after-hour use. Coordinate location with accessible building entry.
- Card reader doors: As needed for authorized after-hour use.
- Electronically scheduled doors: All exterior entrance doors used for ingress during building hours of operations.
- Monitored doors: All remaining exterior doors including loading dock and overhead doors.
- Other door types:
 - Exterior doors that provide access to building services spaces (mechanical, electrical, and grounds rooms) but do not provide access to the building interior may not require access control capability. Review with the Design Manager.
 - Doors equipped with an intercom or other communication device to allow a momentary remote unlocking of doors is permitted in select situations only. Review with Design Manager and Department of Public Safety.

Review location and quantity of each door type described above with the Design Manager.

Special alarm systems

Contact Design Manager early in the design process to review the need for special alarm systems.

Interior Doors

Contact Design Manager early in the design process to review interior security requirements.

Elevator Doors

Do not connect elevator doors to BAC system

BAC - Technical Requirements

Contact Design Manager.

Related Systems and Hardware

Surveillance Systems

Contact the Design Manager early in the design process to review the need for surveillance systems.

Mechanical or battery operated digital security hardware

Provide stand alone mechanical or battery operated digital security hardware for select interior applications only. Contact the Design Manager to review interior security requirements.

FALL PROTECTION ON ROOFS

General

This section specifically includes design requirements and standards for fall protection measures on roofs and skylights. It does not address temporary fall protection measures to be utilized during construction. It also does not address policies and procedures for employee fall protection.

References

Comply with the following:

MIOSHA Part 45 Fall Protection Standard for Construction Industry
MIOSHA Part 2 Wall and Floor Openings, Stairways and Skylights
ANSI/ASSE Z359.1-2007, Parts 3 and 5 and Z359.2-2007, Part 5

Related Sections

UM Design Guideline Sections:

[07500 Roofing Systems](#)

[SID-F Codes and Regulatory Agencies](#)

Design Requirements

Design rooftop areas containing a fall hazard of greater than four feet with specific regard to fall protection. Comply with the following passive protection measures wherever possible:

- Locate equipment (including roof drains) a minimum of fifteen feet from the edge of the roof. This includes any pathways to or around the equipment.
- Include permanent structures such as parapet walls or guard rails together with toe boards at a height of 42" above the roof surface. Note that the guard rails can form a perimeter around the equipment rather than being mounted at the edge of the roof.

If the project budget or architectural considerations preclude using one of the two methods above, obtain the approval of the Design Manager to substitute a permanently mounted anchorage system and/or a horizontal lifeline system for personal fall arrest complying with the following:

- The anchorage system must be designed by a qualified engineer and installed under the supervision of a qualified competent individual.
- The anchorages must be located a minimum of fifteen feet from the roof edge and must be easily accessible.
- The interval between tie-offs must be spaced no more than fifty feet apart.

SID-R

- Anchorages must be situated so as to minimize the fall distance and the possible damage to fall arrest lanyards from nearby sharp or rough edges.
- Anchorage points must be independent of any anchorage being used to support or suspend platforms.

Appropriate fall protection should also be provided for skylights. Guards and/or screens must comply with MIOSHA regulations.

Anchorage points are mandatory for steep pitch roofs (greater than 4:12), whether or not passive protection is also provided.

SUSTAINABLE PRODUCTS PORTFOLIO

General

The [Sustainable Products Portfolio \(SPP\)](#) is maintained by the Sustainability Team at the University of Michigan (U-M) Department of Architecture, Engineering & Construction (AEC). The SPP consists of a list of sustainable products that the University has evaluated and which have been found to meet our sustainable selection criteria. The SPP is a resource that project teams are encouraged to use to select sustainable products. The SPP is not an all inclusive list of available sustainable products and technologies. It is not intended to limit competition or replace creative sustainable design solutions. Sustainable products not on the SPP shall be submitted to the AEC Sustainability Team for review.

Related Sections

[SID-K Sustainable Design and LEED® Requirements](#)

Sustainability Criteria

The criteria used to determine if a product is listed in the SPP include but are not limited to the following:

- Simple to install and easy to maintain
- Long term durability
- Simple to operate
- Reliable
- Aesthetically pleasing
- Competitively priced
- Proven track record
- Replacement parts readily available and fairly priced
- Good local service
- Sustainable manufacturing process
- Sustainability claims can be validated
- Made from Renewable and/or Recycled Materials
- Locally Harvested/Extracted/Manufactured
- Low VOC content

The weight given to each selection criteria will vary from product to product as appropriate for that particular product. The SPP is updated on an ongoing basis and is meant to provide a menu of sustainable products the A/E can select from in confidence knowing such products will ultimately meet U-M's sustainability goals. Additionally, products found not to meet university requirements, for example found unreliable after a "real world" installation period, will be removed from the SPP.

SPP Additions and Changes

Anyone requesting that a product be added to or changed on the SPP must use the [Request for Addition or Change to the SPP Listing](#) form available on the AEC website. The extent of evaluation will vary based on the product; therefore, time to evaluate requests will vary.

If an A/E desires to use a sustainable product not found on the SPP, provide information to the U-M Design Manager, who shall consult with the U-M Sustainability Team for a recommendation. A/Es should provide the information requested on the Request for Addition or Change to the SPP Listing form.

SPP Listing Categories

Products are listed in the SPP in one of three categories:

1. Approved Product (AP): Product has been evaluated and is approved for use on U-M projects
2. Conditional Product (CP):
 - a) Product has been used on select U-M projects; however, post-occupancy evaluation has not been completed. UM Design Manager shall seek approval from the Sustainability Team for the intended use of the product.
OR
 - b) Product has not been used on U-M projects yet; however, a preliminary evaluation of the product indicated that the product meets the UM sustainability criteria if it performs as anticipated. UM Design Manager shall seek approval from the Sustainability Team for the intended use of the product.
3. Not Recommended (NR):
 - a) Product has been used on U-M project(s) and did not perform to the required sustainability criteria. The Sustainability Team does not recommend this product.
OR
 - b) Product has not been used on U-M project(s); however results from an evaluation of the product completed by the Sustainability Team deemed that the product did not perform to the required sustainability criteria. The Sustainability Team does not recommend this product.

LANDSCAPE PLANTINGS

Introduction

This section includes guidelines regarding the preservation of existing plant materials and standards for the design and installation of new plantings.

In general, plantings should be used to:

- Enhance the campus tree canopy (too much science for a landscape design guideline)
Accentuate key focal points, including campus gateways, nodes, building facades and entrances and special exterior features such as artwork installations
- Define special areas such as plazas and seating/gathering points
- Buffer unattractive views to service areas, dumpsters and mechanical equipment
- Create green buffer zones between parking areas and campus
- Control pedestrian access and circulation as needed
- Achieve sustainable design goals such as water conservation, storm water filtering and absorption, urban heat sink reduction, and energy savings with the appropriate use of plants.

Related Sections

U-M Design Guidelines

[02000 Site Requirements](#)

[02215 Soil Erosion and Sedimentation Control](#)

[02810 Irrigation](#)

[01141 Tree Protection Guideline](#) (under development)

Related Documents

LEED Reference Guide for Green Building Design and Construction

[University Planner's Office Stormwater Best Management Practices](#)

Design Requirements

Planting designs should reflect the institutional scale of the campus and the particular setting in which they are located. Landscape plantings should be designed for maximum effect with limited maintenance, emphasizing broad sweeps of similar material. Areas of high visibility, such as the Central Campus Diag, should have a rich palette of native plants; areas of lower visibility, such as service docks, should minimize the use of turf grass by using native grasses and plantings. Detailed and complex plantings should be reserved for courtyards and other areas of smaller scale. High maintenance planting displays should be limited to high visibility areas where such maintenance is warranted.

Conservation of the mature and healthy native flora is essential in areas of campus where mature vegetation stands remain. Native vegetation should be used where additional plant materials are needed to highlight the natural edge. Native plantings should follow the [Grounds Department's](#)

[priority designations guidelines](#). See [01141 Tree Preservation Design Guideline](#) for additional information.

The University of Michigan is committed to using native or near native plantings whenever possible to protect and enhance the integrity of native plant communities, and to reduce the amount of water used for irrigation, maintenance requirements and chemical treatments.

Reduce the amount of manicured lawn in favor of landscaping with native plants and groundcovers. The site's soil type and topology will guide plant selection; performing a soil survey is necessary.

Consider the impact of new construction/renovations on existing landscape materials. Avoid damage to significant vegetation by careful routing of walkways, placement of parking lots and utilities to incorporate existing specimen trees and preventing damage to existing landscape material during construction through robust tree protection.

Avoid plantings within parking lot islands where heat and snow removal activities prohibit healthy growth. Instead emphasize perimeter landscape treatments to buffer views and to provide shade.

Design Manager should always consult with Plant Utilities and Grounds and Waste Management during design phase and ensure Miss Dig contact is noted on all construction drawings.

Plant Selection

Plants will be selected to thrive in the conditions of the site. Consider the cultural and maintenance requirements for each plant before locating on a planting plan. Soil type, Ph. and topology along with water requirements, sun/shade requirements, hardiness, disease resistance and maintenance requirements will guide plant selection.

The A/E's site designer/AEC Design Manager should consult with the Grounds Department for a list of recommended native and other plants. Or, submit for review a plant list of hardy materials with an emphasis on native plants.

In general, removing and or planting trees or significant vegetation within the City of Ann Arbor's R.O.W. is not allowed. However, if approved, the A/E must use the City of Ann Arbor's approved plants list when specifying planting plans within the ROW. In addition, they must work with the University Forester for any proposed tree removals. Tree value costs for trees removed will be factored into the project budget.

Include the following installation requirements in the specifications:

- Perform a thorough weeding before planting the native vegetation. Adequate stabilization will be necessary to help establish the new plantings.

- Remove invasive species when encountered. Hand removal should be implemented wherever possible. (Note: Burning may be utilized for large areas where absolutely necessary. This must be discussed with the Design Manager during design.)

Security and Safety Issues

Plantings should be designed to provide open and unobstructed views and to eliminate concealment opportunities. For personal and safety and security considerations, avoid planting arrangements that create zones of entrapment, limit visual access into gathering spaces or along walkways or otherwise impede visibility from public view.

Deciduous trees should be selected that when mature provide views beyond at a height of 6 to 7 feet from the ground plane to the canopy. Evergreen, ornamental, or shade trees with lower canopy heights should not be used adjacent to walks, vehicular and bike parking areas, or building entrances.

Shrubs that are proposed adjacent to walks, vehicular and bike parking areas, or building entrances should generally be less than 36" tall at mature height. Larger shrubs should be limited to areas where they will not limit visual access or should be used in arrangements that do not create large masses. Plantings that are intended to be hedges should be selected so that mature heights do not exceed 36"

New trees should not be planted adjacent to proposed or existing light poles to avoid disrupting light levels.

Always consider a given plant material's mature state when developing plant spacing diagrams to avoid creating zones of entrapment and/or concealment. The spacing of new plants should be no less than 3/4 the mature spread of the plant.

Existing trees should be scheduled for trimming to remove any branches that impede adequate lighting or obstruct views between the grounds and the canopy.

Designs shall incorporate trimming or removal of shrubs that screen or limit views.

SID-U-H: PATIENT AND STAFF PROTECTION: FALLS, BARIATRICS, LOW VISION, ERGONOMICS

GENERAL:

In general, follow the guidelines below when specifying and designing facilities for UMHC. Unless specifically indicated otherwise, these guidelines are not intended to restrict or replace professional judgment. Comply with all building and accessibility codes listed in [SID-F](#) and [SID-F-H](#).

Architect/Engineering and Interior Designers shall take patient and staff safety into consideration throughout the design of facilities.

Many patients have low vision, limited mobility, and/or medical equipment issues. Staff areas should be designed with ergonomics in mind.

PATIENT AND STAFF PROTECTION GUIDELINES:

Colors and patterns should be selected to clearly differentiate between floors and walls. Floor and wall patterns with sharp contrast should be avoided; however a contrast between floor and wall is desirable.

Corridor handrails should be provided in in-patient areas and outpatient settings where dictated by program.

Designated barrier-free toilet and bathing facilities must meet code, but all patient toilet and bathing facilities should be equipped with grab bars. All patient showers should be equipped with built in, folding seats capable of supporting a minimum of 900 pounds. Note blocking must be installed in the wall capable of supporting this weight.

The distance between the patient bed and the toilet facility should be minimized. Ideally a handrail should be installed between the bed and toilet facility.

Slip resistant flooring and walk off mats should be specified. Loose walk off mats should not be provided.

All accessories and fixtures should be installed with in-wall blocking to secure the item to the wall. Exceptions would be small items that are not expected to bear weight, such as soap dispensers and hand sanitizers.

Seating choices in an area should accommodate bariatric patients and include chair arms.

Glare should be minimized in materials, exterior windows, daylight control and in lighting selection.

Even small thresholds and building expansions joints can be problematic for patients and staff moving IV poles or other equipment. Changes in floor elevation should be avoided; when unavoidable, care should be taken to create a smooth transition.

Many patients at UMHC are in oversized wheelchairs or scooters, and spaces should be designed to accommodate them. Rooms accessed by patients should be provided with oversized doors per the door design guidelines, and consideration given to door hold open devices, automatic operators, and delayed closers.

To the greatest extent possible, all outpatient areas should be accessible by stretcher.

Staff and patient ergonomics, length of reach, and flexibility for individual ergonomics should be considered in the design, for example: reception desks, work stations, appliances and equipment locations, trash receptacles.

Facilities should be designed to accommodate the future installation of patient lifts.

Any glass doors and guardrails should be designed to clearly indicate glass is present; i.e. patterns or other materials included in the design.



SITE FURNISHINGS STANDARDS MANUAL



University Planner's Office
Architecture, Engineering & Construction
University of Michigan
November 12, 2010
<http://www.umaec.umich.edu/>

Table of Contents

Introduction	page 3
Campus Landscape Design Elements	page 4
A. Seating	page 4
B. Tables	page 7
C. Umbrellas	page 10
D. Trash Receptacles	page 11
E. Ash Receptacles	page 11
F. Site Lighting	page 12
G. Bike Racks	page 13
H. Emergency Telephones	page 14
I. Fencing/Railing	page 16
J. Informational Kiosks and SORC Posting Boards	page 17
K. Plazas	page 18
L. Screen Walls	page 18
M. Bus Shelters	page 19
N. Bike Shelters	page 19
O. Signage	page 20
P. Public Art	page 20

Introduction

Intent: The landscape furnishings standards identify design considerations and recommend specific products to be used on the University of Michigan (U-M) campus. Unification of campus environment can be achieved through common landscape furnishings, colors and materials. The intent of these guidelines is to provide clear directions concerning site furnishings for the U-M campus, and to promote consistent and predictable use of public art, lighting, furnishings and fencing.

Flexibility: The recommendations presented are strongly preferred; however, furnishings and materials might vary slightly from project to project and over time. It is recommended that the degree to which landscape features vary be minimized and that shared attributes, such as forms, materials, patterns, style, application-spacing and color be consistent. In special situations, alternatives may be evaluated on a case-by-case basis to ensure that the design standards are followed.

Exceptions: Any exceptions to the guidelines will require review by the University Planner's Office (UPO) and the [Exterior Elements Design Review Committee](#) (EEDR).

Principles: Standard campus furnishings can help to integrate the campus environment and can further advance the sense and legibility of the place. The following principles summarize the intent of the guidelines.

- 1) Unification with common design elements
 - a. Develop uniform landscape and site treatments for common problems and issues.
 - b. Establish a more unified palette of materials for lighting, site furnishings, and landscape and hardscape elements.
 - c. Enhance campus legibility and structure of campus.
- 2) Beautification and appearance of the campus
 - a. Maintain and improve the visual quality of campus landscape.
 - b. Establish a more visible and compelling public art presence.
 - c. Develop signature amenities and improvements throughout the campus areas.
 - d. Cluster furnishings to maximize effective use and minimize the negative visual impact within landscape.
- 3) Others
 - a. Minimize and standardize maintenance requirements.
 - b. Consider the limitations and needs of persons with disabilities to minimize potential obstructions and hazards.
 - c. Minimize life-cycle costs by utilizing high quality products that are durable, backed by a solid warranty and vendor reputations and are comfortable and aesthetically pleasant.
 - d. Provide furnishings where there is an existing demonstrated or potential future need.
 - e. Arrange furnishings to take advantage of desirable views and avoid facing furniture toward areas such as loading docks, dumpsters, or parking.
 - f. Install per U-M campus standards.

1. Campus Landscape Design Elements

The following section describes the recommended site furnishing material selection and design detail opportunities that will comprise the campus landscape design vocabulary. It is intended that repetitive use of this design vocabulary in the various campus development projects will result in a more organized, unified and beautiful campus. A single style of furnishings for each element described in the manual should be used exclusively to establish a unified and attractive campus character.

A. SEATING

1) Surface Mounted/In Ground Benches

a) Design Considerations

- Select bench locations in potential gathering areas to create comfortable settings conducive to conversation as well as security.
- Locate in a comfortable setting protected from vehicles/elements, and preferably with some landscaping and shading from the sun.
- Backless benches may be used in places where two-sided access and use are expected.
- Metal is preferred for durability.
- Complement existing standard furnishings, as well as landscape context and architectural features.
- Locate on and anchor to pavement. Benches should be set with a minimum setback of 12"-16" from edge of lawn to reduce damage from maintenance equipment.

b) Design Recommendations

- Plexus II collection from Landscape Forms Inc. is recommended as standard.



- Black powder coat is preferable.
- Alternative products on similar lines, including Forms + Surfaces, Sitescapes, and Victor Stanley, may be considered when approved by UPO.

2) Wall Mounted Benches

a) Design Considerations

- Wall mounted benches are preferred when snow removal and other maintenance is a concern.
- Select bench locations in potential gathering areas to create comfortable settings conducive to conversation as well as security.
- Locate in a comfortable setting protected from vehicles/elements, and preferably with some landscaping and shading from the sun.
- Metal is preferred for durability.
- Complement existing furnishings as appropriate, as well as landscape context, and architectural features.

b) Design Recommendations

- Plexus II collection from Landscape Forms is recommended as standard.



- Black powder coat is preferable.
- Alternative products on similar lines, including Forms + Surfaces, Sitescapes, and Victor Stanley, may be considered when approved by UPO.

3) Chairs

a) Design Considerations

- Freestanding chairs should be considered in courtyards, atriums or places that can be secured. They should not be considered in public or unsecured areas.
- Select chair locations in potential gathering areas to create comfortable settings conducive to conversation as well as security.
- Locate in a comfortable setting protected from vehicles/elements, and preferably with landscaping and shading from the sun.
- Complement existing furnishings as appropriate, as well as landscape context and architectural features.
- Metal is preferred for durability.
- Locate on the pavement with a minimum setback of 12"-16" from edge of lawn to reduce damage from maintenance equipment.

b) Design Recommendations

- Verona collection from Landscape Forms is recommended as standard. Black powder coat is preferable. The recommended specification is a Verona free standing arm chair.



- Alternative products on similar lines, including Forms + Surfaces, Sitescapes, and Victor Stanley, may be considered when approved by UPO.

4) Memorial/Commemorative Benches

a) Design Considerations

- A limited number of options have been approved for use as memorial or commemorative benches, see guidelines (<http://www.umaec.umich.edu/eedr/index.html>).
- Consult with UPO regarding requests for memorial or commemorative benches.

B. TABLES

1) Café Tables

a) Design Considerations

- If patio areas will be plowed in the winter, coordinate placement with Grounds depending upon the type of equipment to be used.
- Complement existing furnishings as appropriate, as well as landscape context and architectural features.
- Provide trash receptacles in close proximity.
- Locate them near dining and food vending areas.
- Consider umbrellas for shade where ever appropriate. Umbrellas must be permanently anchored to table; tables with umbrellas must be anchored to the ground.
- Locate on and anchor to pavement. Benches should be set with a minimum setback of 12"-16" from edge of lawn to reduce damage from maintenance equipment.
- Tables must be anchored on a clear, paved pathway in order to be wheelchair accessible.
- Five-seat table with an open space for wheelchair access is preferred.

b) Design Recommendations

- The recommended standard is Carousel by Landscape Forms. Both back and backless seats are acceptable.



- Black powder coat is preferable.
- Alternative products on similar lines, including Forms + Surfaces, Sitescapes, and Victor Stanley, may be considered when approved by UPO.

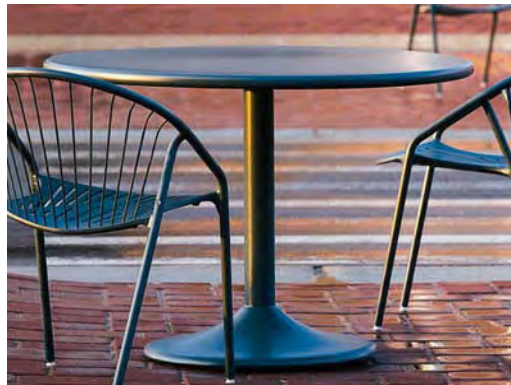
2) Free Standing Tables

a) Design Considerations

- Freestanding tables should be considered in courtyards, atriums or places that can be secured. They should not be considered in public or unsecured areas.
- If patio areas will be plowed in the winter, coordinate placement with Grounds depending upon the type of equipment to be used.
- Complement existing furnishings as appropriate, as well as landscape context and architectural features.
- Provide trash receptacles in close proximity.
- Locate them near dining and food vending areas.
- Locate the table on the pavement. Tables should be set with a minimum setback of 12"-16" from edge of lawn to reduce damage from maintenance equipment.
- Tables must be located on a clear, paved pathway in order to be wheelchair accessible.

b) Design Recommendations

- The recommended standard is a 36" Catena top by Landscape Forms with freestanding base.



- Black powder coat is preferable.
- Alternative products on similar lines, including Forms + Surfaces, Sitescapes, and Victor Stanley, may be considered when approved by UPO.

3) End Tables

a) Design Considerations

- Select locations to create comfortable and multi-functional spaces.
- If patio areas will be plowed in the winter, coordinate placement with Grounds depending upon the type of equipment to be used.
- Complement existing furnishings as appropriate, as well as landscape context and architectural features.
- Provide trash receptacles in close proximity.
- Locate them in potential gathering spaces and near to existing buildings.
- Locate in a comfortable setting protected from vehicles/elements, preferably with landscaping and shelter to the back, and shading from the sun.
- Locate on and anchor the table on the pavement. End tables should be set with a minimum setback of 12"-16" from edge of lawn to reduce damage from maintenance equipment.

b) Design Recommendations

- The recommended standard is the backless Plexus II series bench by Landscape Forms.



- Black powder coat is preferable.
- Alternative products on similar lines, including Forms + Surfaces, Sitescapes, and Victor Stanley, may be considered when approved by UPO.

C. UMBRELLAS

a) Design Considerations

- Consider umbrellas for shade wherever appropriate.
- Umbrellas must be permanently anchored to table.
- Complement existing furnishings as appropriate, as well as landscape context and architectural features.

b) Design Recommendations

- The recommended standard is an 8" Equinox umbrella from Landscape Forms.



- Metal umbrella is preferred.
- Black is the preferred color for umbrella and pole; however, on certain occasions the color can complement surrounding architectural or site features. The powdercoated pole should match the color of the umbrella.
- Alternative products on similar lines, including Forms + Surfaces, Sitescapes, and Victor Stanley, may be considered when approved by UPO.

D. TRASH RECEPTACLES

a) Design Considerations

- Trash receptacles should be compatible with benches and other furnishings, along with building architecture.
- Group with other furnishings to mitigate visual impact.
- Receptacles should be located in areas of high pedestrian traffic, such as sitting areas, building entries, patios, bus stops and campus plazas.
- Ensure trash receptacles are simple and unobtrusive design and easy to service.
- Provide removable insert to dump trash.
- Place in unobtrusive locations with a minimum 3' setback along main pathways.
- Locate on and anchor the trash receptacle on the pavement. Set receptacles 12"-16" from edge of lawn to reduce damage from maintenance equipment.

b) Design Recommendations

- The recommended standard is Victor Stanley S-242, fabricated metal receptacle, 36-gallon capacity, with domed lid.



- Black powder coat is recommended.
- Alternative products on similar lines, including Forms + Surfaces, Sitescapes, and Landscape Forms, may be considered when approved by UPO.

E. ASH RECEPTACLES

- The University of Michigan is a smoke free campus (as of July 2011), and therefore ash receptacles will not be installed on university property. If issues arise before July 2011, consult UPO.

F. SITE LIGHTING

a) Design Considerations

- Establish lighting theme to complement campus facilities.
- Develop landscape lighting in parking lots that complements street and pedestrian lighting.
- Select and install a uniform lighting equipment style, to reinforce campus design theme. Coordinate selection of lighting equipment with campus standards.

b) Special Lighting Criteria

- Public art and landscape features may be accent lighted in conformity with campus standards and the lamp must be shielded from offsite view.
- Accent lighting equipment shall be of sufficient quality to resist vandalism and minimize maintenance. Preferred luminaries shall be flush to grade.
- Backlit, reverse pan channel signage systems are preferred for optimum readability of signage. LED systems are encouraged.
- Façade lighting shall require special review by the Exterior Elements Design Review Committee.
- Refer to section 16521 of the U-M master specifications on "Outdoor Lighting" for further details

<http://www.umaec.umich.edu/for.archs/masterspec.html>

G. BIKE RACKS

a) Design Considerations

- Select a bicycle rack or hoop style that complements other furnishings and is attractive within the campus environment.
- The design should be simple, space efficient and serviceable.
- Racks should be placed to avoid conflicts with pedestrians. Locate bike loops close to building entrances where ever possible.
- Locating the bike hoops under building overhangs or other sheltered areas is preferable.
- Locate bike hoops close to bike paths, if it is not close to a building entrance.
- Bike parking area should be well lit.
- Work with UPO to decide the appropriate quantity of racks for the site.
- Racks should be installed usually on a wide sidewalk with 8 or more feet of clear sidewalk space remaining.
- Space 3' on center or 2'9" if absolutely necessary. Offset 4-5' from walks and 2' on ends and back to edge pavement.

b) Design Recommendations

- For general campus use, Matte Black PVC coated 1 and a 1/2" SCHD 40 1.9 O.D. bike hoop by S&G products 5117-546-9240 or approved equal.



H. EMERGENCY TELEPHONES

1) Free standing (kiosk)

a) Design Considerations

- Each new exterior project shall consider the installation of additional blue light emergency phones. Designers shall work closely with Department of Public Safety (DPS).
- Locations should be easily accessible to pedestrians, easily maintainable, and reviewed by DPS prior to finalizing design.
- Stagger the emergency phones throughout pedestrian corridors and provide at major road and walk intersections, especially in areas with poor visibility from roads.
- Locate on a concrete pad paved up to walkway for accessibility per university construction standard detail.

b) Design Recommendations

- All telephone stanchion, telephone backbox, beacon, stanchion light, phone and phone line should be furnished and installed by U-M ITCOM.

2) Surface Mounted

a) Design Considerations

- Locations should be easily accessible to pedestrians, easily maintainable, and reviewed by DPS prior to finalizing design.
- Stagger the emergency phones throughout pedestrian corridors and provide at major road and walk intersections, especially in areas with poor visibility from roads.
- Surface mounted phones should be considered when the surface below is occupied and creates limited conditions. Surface mounted is also preferred when a pedestrian way located adjacent to a building; when trying to avoid any obstruction in snow removal from pedestrian ways; and where there is need to locate on tunnels/vaults.

b) Design Recommendations

- All telephone stanchion, telephone backbox, beacon, stanchion light, phone and phone line should be furnished and installed by U-M ITCOM.

I. FENCING/RAILING

1) Ornamental Fence

a) Design Considerations

- Utilize along campus periphery, especially along roads and main corridors.
- Use within campus when aesthetically appropriate.

b) Design Recommendations

- Railing should be anodized aluminum with dark brown bronze powder coat finish. Other finish colors may be utilized depending on the location but require approval but UPO.
- Railing should be J.G Braun company series 950 style B heavy-duty aluminum railing or any equivalent approved by UPO.

2) Chain Link Fence

a) Design Considerations

- Use minimally and with discretion for enhancing safety or for a special area that needs protection from pedestrian traffic, or to restrict a vehicle from illegally leaving a parking lot.
- Minimize use along major pedestrian and vehicular thoroughfares.
- Use 2" spacing for general purpose and smaller openings for high-security areas.

b) Design Recommendations

- Black welded steel construction chain link is generally preferred.
- Use of black vinyl screen is recommended.
- Installation to follow U-M construction standards.

3) Post and chain

a) Design Considerations

- Post and chain is generally used for pedestrian control and is not intended for security and safety. However, this should be used as a last resort when it is not possible to redesign the landscape to direct pedestrians away from a sensitive area.
- Use single chain for vehicular control and double chain design for pedestrian control.
- It is used in areas where portable separation is needed, since this can be moved when necessary.

b) Design Recommendations

- Post and hardware available from South Lyon Fence. Chain is 5/16" black metal.

J. INFORMATIONAL KIOSKS AND SORC POSTING BOARDS

1) Informational kiosks for flyers

a) Design Considerations

- Locate on top of vents that are along major pedestrian corridors.
- Location should not be an obstruction during snow removal.
- Placement to be approved by UPO and EEDR.

b) Design Recommendations

- The information kiosk is custom designed and built, see UPO for details. Refer [here](#) for more information.



2) Student Organization Resource Center (SORC) boards

a) Design Considerations

- Locate along major pedestrian corridors and at major pedestrian gathering spots.
- Incorporate surfaces that display variety of information in a variety of directions.
- Location should not be an obstruction during snow removal.
- Placement of SORC boards is to be approved by UPO.

b) Design Recommendations

- The posting board follows a specific design that requires custom construction.



K. PLAZAS

a) Design Considerations

- Provide appropriately sized space and furnishings that promotes social gatherings, sitting and group gatherings.
- Create visual interest and encourage design responses that consider incorporation of appealing pavement patterns, seating, artwork, walls and spatial organization.
- Avoid designs that create too much enclosure and create security hazards.
- Contact UPO regarding design process.

b) Design Recommendations

- Provide amenities like lighting and furnishings from a standard palette as a component of design.
- Contact UPO for guidance.

L. SCREEN WALLS

a) Design Considerations

- Screen walls should be placed so they do not block important views or impede visibility of vehicles.
- Retaining walls should not be higher than 18" from grade to top of slope, otherwise a handrail will be required.

b) Design Recommendations

- For visible areas, use an architectural concrete/stone or masonry.
- For less visible areas, concrete is appropriate.

M. BUS SHELTERS

a) Design Considerations

- The A/E should work with UPO, Parking and Transportation Services and Public Safety to locate shelters.

b) Design Recommendations

- Contact UPO for the standard model information.



N. BIKE SHELTERS

c) Design Considerations

- Locate in high-use areas where existing bike racks are exposed to the elements.
- Cluster bike parking in groups that serve multiple buildings.
- Ensure that the placement of the parking and shelter do not impede the flow of pedestrians or otherwise block the ingress/egress of fire and emergency vehicles or personnel.

d) Design Recommendations

- The recommended standard is Duo Guard's Parachute, modified to U-M specifications.
- Frosted glass top and black powdercoated steel is preferred.



O. SIGNAGE

- Exterior signage follows specifications as set forth in the Wayfinding and Signage Guidelines (<http://www.umaec.umich.edu/eedr/index.html>). Consult with UPO in regard to all exterior signage.

P. PUBLIC ART

- Placement of public art on the campus grounds is administered by the President's Advisory Committee on Public Art (<http://www.public-art.umich.edu>), with site requirements determined by the UPO.



STORMWATER BEST MANAGEMENT PRACTICES



University Planner's Office

Architecture, Engineering & Construction

University of Michigan

November 12, 2010

<http://www.umaec.umich.edu/>

Table of Contents

A. Abbreviations	page 3
B. Stormwater Management	page 4
Non-structural	
1. Site disturbance and soil compaction	page 4
2. Natural/intermittent streams and swales	page 4
3. Buffer areas	page 5
4. Impervious surfaces	page 5
5. Overland flow	page 6
6. Terrain	page 6
Structural	
7. Bio-retention areas	page 6
8. Forebays and detention basins	page 6
9. Vegetated swales/filter strips	page 7
10. Underground filter chambers	page 7
11. Green roof	page 8
12. Native revegetation	page 8
13. Soil remediation program	page 9
14. Porous pavement	page 9
C. Compliance	page 10

The Stormwater Best Management Practices Manual is a companion OSEH's Stormwater Management Program Plan (<http://www.oseh.umich.edu/stormwater/SWMP2010.pdf>) and to the AEC Design Guidelines, which designers must also adhere to (<http://www.umaec.umich.edu/desguide/index.html>).

Preliminary & Advisory

A. Abbreviations

1. U-M – University of Michigan
2. AEC – Architecture, Engineering & Construction
3. UPO – University Planner’s Office
4. DPS – Department of Public Safety
5. Grounds – Plant Department/Grounds
6. OSEH – Occupational Safety and Environmental Health
7. BMP – Best Management Practices

Preliminary & Advisory

B. Stormwater Management

Goals: Use site specific strategies to minimize infrastructure costs, protect water quality and prevent flooding, erosion and other negative impacts to campus buildings, infrastructure and the natural environment; maintain hydraulic balance in each watershed, particularly for site disturbance greater than 1 acre (<http://www.oseh.umich.edu/stormwater/SWMP2010.pdf>); minimize impervious coverage.

Non-Structural Strategies:

1. Limit site disturbance and soil compaction

It is important to minimize soil compaction and site disturbance caused by construction activities. Avoiding compaction increases soil infiltration capacity, maintains a healthy environment for vegetation and preserves drainage ways and natural catchment areas. Site specific strategies for minimizing disturbance through design and construction practices include:

- a. Limit areas of heavy equipment access and staging/storage of materials.
- b. Identify and protect high-quality and environmentally sensitive areas- do not allow any disturbance to take place in these areas.
- c. Identify areas which will be vegetated after construction- avoid disturbance in these areas (clearing, but not grading).
- d. Avoid extensive and unnecessary clearing and stockpiling of topsoil.
- e. Restore soil permeability to compacted areas that occurs during construction.
- f. Place temporary fencing around tree drip lines to avoid destruction of tree roots (following these guidelines:
<http://www.aec.bf.umich.edu/for.archs/details/general/01141001-Tree%20Protection.pdf>).
- g. Minimize grading by designing to the existing topography.

For detailed instructions refer to technical section 02215

(<http://www.aec.bf.umich.edu/desguide/tech/02/02215.pdf>).

2. Protect natural and intermittent streams and swales; maintain as natural habitat and campus amenity

Identify, protect, and utilize natural drainage features, such as swales, low areas and watercourses as a means of protecting water quality. This maximizes the site's natural hydrological characteristics, reducing the need for structural management practices and minimizing construction and maintenance costs. Items to consider:

Preliminary & Advisory

- a. Identify and map natural drainage features (e.g., swales, streams, low areas, wetland, etc.). Use signage and fencing for protection.
- b. Utilize natural topographic/drainage features to guide site design.
- c. Direct surface drainage to natural drainage features.
- d. Prevent erosion of natural drainage features by using upstream volume and rate control practices, such as level spreaders, erosion control matting, re-vegetation and outlet stabilization.

3. Protect and restore buffer areas to promote filtration

Natural vegetated areas are important components of an integrated stormwater management system that help protect water quality by stabilizing banks, mitigating flow rates, and filtering of pollution and sediment. Items to consider:

- a. Plan wide planted buffer zones/setbacks around drainage courses, ponds and wetland.
- b. Limit the amount of impervious surfaces and industrial uses allowed adjacent to buffer areas.
- c. Restrict clearing of vegetation within a 100-year floodplain.
- d. Restore buffer areas by revegetating it with native plantings, if necessary.

4. Reduce impervious surfaces

Reducing impervious surfaces includes minimizing the dimension or area required for roads, drives, walks and parking. When pavement is reduced, the rate of stormwater runoff is decreased while infiltration is increased. Items to consider:

- a. Evaluate traffic volumes and parking requirements taking into consideration average and peak use demand.
- b. Remove unutilized/underutilized impervious coverage.
- c. Consider minimizing impervious road and parking areas by incorporating pervious paving materials, where appropriate.
- d. Use pervious materials for plazas and sidewalks, and bike parking areas, where appropriate.
- e. Reduce setbacks along roads to minimize length of access driveways and approach walks.
- f. Analyze the site to determine if smaller parking spaces, slanted parking stalls, compact car spaces, and narrowed traffic lanes is appropriate.

5. Promote overland flow

Promote overland flow to minimize need to costly infrastructure/reduce downstream impacts.

6. Work with existing terrain

Work with the site's existing terrain to mitigate negative environmental effects. Items to consider:

- a. Orient site surface features (roads, parking, walks, etc.) along existing contours to reduce need for cut/fill operations.
- b. Avoid increasing run-off on adjacent non-university properties, as well as avoid impacting neighboring site overland flow.

Structural Strategies

7. Incorporate bio-retention areas

Bio-retention areas, also referred to as rain gardens, are depressed surface areas – typically no more than one acre in size – that are planted with carefully selected native plantings whose function is to capture and treat stormwater runoff from rooftops, streets and parking lots. These areas help to moderate stormwater runoff, promote groundwater recharge and infiltration, create an aesthetically pleasing setting, provide wildlife habitat, and mitigate heat island effect if properly designed and located. Items to consider:

- a. A commitment to regular maintenance is necessary so that the rain garden does not become over-run by weeds and non-native vegetation.
- b. In order to prevent clogging, a vegetated buffer strip, inlet or sediment trap should be installed prior to the runoff entry into the garden.
- c. Surface area should not exceed 5:1 impervious drainage area to bio-retention; ponding depth is recommended at 6 inches.
- d. Planting live material is preferred to seeding.

8. Utilize forebays and detention basins

Detention basins are temporary stormwater storage areas that are used to help prevent downstream flooding by moderating stormwater runoff peaks. There are four different types: dry ponds, wet ponds, constructed wetlands and underground detention. Forebays are smaller basins designed to take the initial “flush” of stormwater and slow the rate of flow before releasing into the detention basin. They are separated from the basin. Items to consider:

- a. Assess storage capacity of pond in lieu of available site area and soil/subsurface conditions.

Preliminary & Advisory

- b. Consider combining with other BMPs for an integrated solution.
- c. Plan for regular maintenance – vegetation and sediment removal.
- d. Evaluate surrounding sites when considering the development of a detention basin. Consider strategically locating a larger detention basin as opposed to constructing several smaller basins.
- e. Detention basins should be designed to accommodate one-year through a one hundred-year rainfall.
- f. A minimum length to width ratio of 2:1 is recommended; the shape should maximize stormwater flow pathway and irregularly shaped basins are acceptable. Slopes in and around the basin should be horizontal to vertical, 4:1 to 5:1; the maximum water depth should not exceed 10 feet.
- g. Forebays should be vegetated to improve runoff and stabilize the soils. They should have a minimum length of 10 feet and be physically separated from the pond by a wall or berm.

9. Create vegetated swales/filter strips

Vegetated swales/filter strips are permanent, maintained strips of vegetation designed to slow runoff and filter out sediment and other pollutants from stormwater. Sheet flow must be maintained across filter strips. Appropriate applications for filter strips are where runoff is directed from impervious areas such as roads and parking. Items to consider:

- a. Use level spreaders to promote even flow/filtering capability across the filter strip.
- b. To ensure that large storms safely bypass the filter, install flow splitters or multi-stage chambers.
- c. Maintain relatively level slope to ensure optimum filtering.
- d. In areas with high level of debris, pretreatment such as oil/grit separators and vegetated filter trips may be necessary.
- e. Ensure that the ratio of drainage area to filter strip is in balance (not to exceed 6:1).
- f. Create a dense plant filter strip with a mix of salt and drought-tolerant plant material. Refer to Grounds for a list of recommended plants.

10. Incorporate underground filter chambers

An underground filter chamber is a large subsurface structure with at least two chambers capable of receiving relatively large amounts of stormwater flow. One chamber of the filter settles large particles while the other contains material that is capable of filtering small particulate matter. Filtered water discharges through an outlet pipe. Items to consider:

- a. [get AEC-Civil input]

Preliminary & Advisory

11. Consider a green roof

Green roofs, also referred to as vegetated roofs or roof gardens/terraces, are conventional roof top structures that are overlain with a layer of vegetation that allows the roof to function like a vegetated ground surface. The overall thickness of the vegetated roof can range from two inches to several feet depending upon the structural integrity of the roof system. A green roof profile typically consists of many layers, including waterproofing, insulation, specialized soil, filter fabric, and vegetation. Items to consider:

- a. Analyze structural integrity/load bearing capability of the roof to ensure proper design.
- b. Insure roof to accept green components do not exceed a 2:12 slope to prevent slippage; roofs with slopes greater than 2:12 must incorporate supplemental measures.
- c. Separation fabric should be readily penetrated by roots, but provide a durable separation between the drainage and growth media layers.
- d. Use drought resistant plants.
- e. Incorporate means of watering roof during times of extreme drought.
- f. Ensure safe/adequate access for maintenance personnel and equipment.
- g. During plant establishment, several weeding, fertilizations and infill plantings should occur. Once the plants are established, only annual maintenance is necessary.
- h. Check roof warranty to ensure green roof installation does not terminate its validity.

For detailed instructions refer to technical [section](http://www.aec.bf.umich.edu/desguide/tech/02/section_02_01.pdf)
(http://www.aec.bf.umich.edu/desguide/tech/02/section_02_01.pdf).

12. Restore developed areas with native revegetation

Native revegetation can occur in a woodland, no-mow lawn area, buffer area, prairie and constructed wetlands. There are many benefits including reduced maintenance needs, beautification, improved water quality and reduced volume of runoff. Items to consider:

- a. The site's soil type and topology will guide plant selection. Performing a soil survey is necessary.
- b. Perform a thorough weeding before planting the native vegetation.
- c. Adequate stabilization will help to establish the native plantings.
- d. The first year will require more maintenance (weeding and watering) than subsequent years.

For detailed instructions refer to technical [section](http://www.aec.bf.umich.edu/desguide/tech/02/section_02_02.pdf)
(http://www.aec.bf.umich.edu/desguide/tech/02/section_02_02.pdf).

13. Institute a soil remediation program

Soil restoration is a technique used to restore soils by physical treating and/or mixing natural additives into the soil where it has been compacted by construction activities or general use over an extended period of time. By employing de-compacting measures, water retention capacity of the soil is increased, erosion is reduced and the overall soil structure and composition is improved to support healthy plant growth. Items to consider:

- a. Evaluate existing soil conditions before implementing a restoration strategy to determine amount of soil compaction. A density test will need to be conducted.
- b. Tilling the soil should only be used on dry soils. This should be performed before any soil amendment is applied.
- c. For major compaction, till to a depth of 20 inches; for minor, 8 inches.
- d. Soil media should not be applied on slopes greater than 30%.
- e. Restoration should not take place within the critical root zone of trees.
- f. The tilling should create a two-directional grid, spaced 12 -36 inches apart.

14. Encourage use of porous pavement

Porous pavement is utilized to promote stormwater filtration. There are many different types including: porous concrete, porous asphalt, porous concrete unit paver and grass-crete (or equivalent). The potential use a pervious pavement system should be evaluated early in the design process.

- a. Systems
 - i. Porous concrete, or pervious concrete, is created by reducing the number of fines added to a standard mix in order to establish drainage voids. The pervious pavement should be underlaid with a stone sub-base for cold climates.
 - Underlay pervious pavement with a stone sub-base for cold climate areas
 - Installation methods and outcomes should be carefully observed where grading requirements are stringent. Installation involves rolling the concrete instead of vibrating and currently has been observed to leave the finished surface slightly 'sagged' in the center of the roller.
 - There is a definite distinction in color between concrete batch installations.
 - ii. Porous or pervious asphalt is essentially standard bituminous asphalt into which fines have been screened and reduced, allowing water to pass through small voids. Pervious asphalt is typically placed directly on the stone sub-base in a single layer and rolled into a finished surface. Porous asphalt is typically used for parking lots; however, applications could include walkways in natural areas.
 - iii. Porous concrete unit pavers, or permeable paver blocks, are interlocking units (often concrete material) that, when placed together in a system, allow water

Preliminary & Advisory

to drain through and into the sub-base zone or directly into the soil. The paving units themselves come in all sizes and colors and are particularly suited for high images areas such as courtyards and plazas. Units can be specified that are capable of taking heavy loads, such as parking lots, service areas and low-speed drives.

- Accessible ramps within porous paver areas should be considered as standard concrete pavement to achieve and maintain the required grades.

When working in areas of known contaminated soils, refer to OSEH's Stormwater Management Program Plan <http://www.oseh.umich.edu/stormwater/SWMP2010.pdf>.

For detailed instructions refer to technical section 02510 (<http://www.aec.bf.umich.edu/desguide/tech/02/02510.pdf>).

B. Compliance

1. AEC - Civil Design Guidelines and Specifications
2. Soil Erosion and Sedimentation Control
3. Tree Protection Policy
4. Storm Water Management Plan (OSEH)
5. American with Disabilities Act
6. Wayfinding and Signage Guidelines
7. All applicable building codes http://www.umaec.umich.edu/desguide/sid/sid_f.pdf
8. Guidebook of Best Management Practices for Michigan Watersheds
9. Campus Exterior Operations Review
10. Exterior Elements Design Review
11. AEC Plan Review Process

Preliminary & Advisory



- HOME
- ABOUT US
- PROJECTS
- MAPS & DETOURS
- MASTER PLANNING
- POLICIES & PROCEDURES
- SUSTAINABILITY
- SAFETY

- FOR U-M CLIENTS
- FOR VENDORS
- FOR U-M AEC STAFF

OUT TO BID

DESIGN GUIDELINES

CODES & REGULATORY AGENCIES

DESIGN DELIVERABLES

SUSTAINABILITY

SPECIAL INSTRUCTIONS TO DESIGNERS

SPECIAL BUILDING AREAS

OFFICE SPACE

TECHNICAL SECTIONS

STANDARD DETAILS

MASTER SPECIFICATIONS

PREFERRED MANUFACTURERS

HEALTH SYSTEM PROJECTS

EFFECTIVE DATE

BUILDING COMMISSIONING

CONTRACTS & AGREEMENTS

CONTRACTOR RESOURCES

OTHER LINKS

SPECIAL BUILDING AREAS

Special Building Areas contains design criteria and design approach specific to certain building or room types.

SECTION	Date	Previous Versions
SBA-A Animal Facilities	November 2013	September 2008
SBA-B Loading Docks	August 2014	May 2003
SBA-C Telecommunication Rooms	August 2013	November 2012
Health System Projects only SBA-C-H: Requirements for Telecommunications Rooms in UMHC Facilities		

SBA-D Custodial Closets	May 2003 	April 1995 
Health System Projects only SBA-D-H Custodial Closets In UMHHC Facilities 		
SBA-E Parking Structures	October 2009 	June 2009 
SBA-F Unit Sub-Station Rooms	October 2009 	June 2009 
SBA-G Personal Rooms	February 2013 	April 2005 
SBA-H Tunnels	November 2005 	
SBA-I Gender Inclusive Toilet/Locker Room	July 2014 	November 2005 
SBA-J Fire Command Center	May 2006 	
Health System Projects only		
SBA-K-H Healthcare Procedure Room Infection Control Types And Requirements 		
SBA-L-H Patient Care And Support Spaces Room Type Requirements 		
SBA-M-H: UMHHC Patient and Staff Protection: Falls, Bariatrics, Low Vision, Ergonomics 		

U-M Gateway | Business & Finance | Facilities & Operations
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ANIMAL FACILITIES

Scope

Obtain approval of the Provost's Office and Office of the Vice President for Research (OVPR) for all new animal facilities. Secure the written approval of the Provost's Office (Vice Provost for Academic and Budgetary Affairs) prior to finalizing program documentation. It is the responsibility of the unit requesting such spaces to obtain approval prior to initiating design activities.

In addition to the requirements of this Guideline, comply with the American Association for the Accreditation of Laboratory Animal Care (AAALAC) and the National Institutes of Health (NIH) criteria for the housing, handling and caring of laboratory animals. If a conflict should arise during the design of a specific project, the requirements of AAALAC and NIH will typically take precedence. Consult with the Design Manager who will coordinate with University Committee for the Use and Care of Animals (UCUCA) and the Attending Veterinarian (AV).

The Enforcing Agency for Animal Facilities is the UCUCA, which includes the University's AV. Design Manager will arrange for consultations with the UCUCA Office and the AV early in Schematic Design.

Related Sections

U-M Design Guideline Section:

[SID-F Codes and Regulatory Agencies](#)

[SID-Q Building Access Control](#)

[230910 Laboratory Ventilation \(Currently 15910\)](#)

[263000 - Engine-Generator System \(Currently 16231\)](#)

Reference Documents:

"Guide for Care and Use of Laboratory Animals", promulgated by United States Department of Health and Human Services, and the Regulations of the Federal Animal Welfare Act 9, CFR Parts ,1 2 and 3

Project Documents

Eliminate sensitive terms from the project drawings, specifications, and other review and bidding documents. "Sensitive terms and descriptions" include both specific and general information regarding the animal species and research activities conducted in animal facilities. Appropriate terminology includes research laboratory, support space, procedure room, operating room, clean and/or dirty room, housing, etc. Consult with the Design Manager early in the design process to review terminology requirements.

Location

Separate animal suites including procedure rooms from offices and main pedestrian corridors to discourage unauthorized access and to mitigate odors.

Animal areas need to be secured with access restricted to only authorized personnel. Provide access control system connected to Campus or Hospital central system depending on the location of the facility.

Determine whether a closed circuit TV system is needed for the facility being designed.

Wherever possible, provide ready access to an elevator that can be segregated and secured from the public for the transportation of animals, cages, feed, bedding, waste, etc. Determine whether a dedicated elevator is required for the facility.

Do not locate the animal suite above electrical rooms, telephone/data rooms, or other rooms that could be damaged if water leaks down after wash-down of the animal rooms.

When positioned along a perimeter wall, do not install exterior windows in animal rooms.

House noisy species apart from other quieter species. Consider impacts of building environmental noise when locating individual species housing and procedure areas.

Strategically locate support areas (including but not limited to food and bedding storage rooms, hazardous agent storage rooms, clean and soiled cage holding rooms, cage washer rooms, refuse rooms, animal care equipment storage rooms, and animal care personnel lavatory, shower and locker rooms) to isolate housing rooms from rooms requiring more frequent / less restricted access.

Corridors

Main corridors shall be 7 feet wide. Branch corridors shall not be less than 5 feet-6 inches wide.

Surfaces

Surfaces shall be constructed of materials that are waterproof and easily sanitized.

Use epoxy painted cement block walls, epoxy painted plaster ceilings, and smooth texture acid and solvent resistant monolithic floors with integral coved base . All pinholes must be filled.

Protect walls with guard rails.

In renovations of existing facilities, certain less-desirable features may be unavoidable. The following compromises are examples. Obtain permission from Design Manager for these and other deviations from stated requirements:

- Water-resistant gypsum drywall-on-metal-stud partitions.
- Vinyl-covered gypsum lay-in suspended ceiling panel ceilings in galvanized grid with hold down clips.
- Projecting items such as thermostats are undesirable, but if absolutely necessary, shall be protected with bumpers or guards.
- Exposed overhead pipes and conduits. If required, the penetrations shall be sleeved and sealed. All floor penetrations shall have sleeves and be sealed watertight.
- Above-ceiling devices requiring service or maintenance. If required, provide waterproof access panels. Utility valves should be located above the corridor ceiling.

Doors

- Size: 42 inches wide by 84 inches high minimum
- Type: Galvanized hollow metal. Review viewing window and related light control requirements with Design Manager.
- Configuration: Typically in-swinging into housing rooms; however, direction may vary based on code requirements and traffic flow. In some locations, closing direction should be coordinated with air flow direction..
- Hardware:
 - University Standard mortise digital combination lock.
 - Delayed action closer.
 - Door protection - armor plates and trim protection.
 - Tight fitting self-sealing neoprene sweeps or surface mounted automatic door bottoms. Avoid projecting thresholds for ease of cart traffic.

Ventilation Systems

See Design Guideline technical section, *Laboratory Ventilation* for vivarium ventilation requirements.

Environmental Controls

Individual room temperature shall be DDC and have local setpoint adjustment. Review temperature and humidity requirements with Design Manager and ULAM management early in design process. Temperature (and to a lesser degree, humidity) must be tightly controlled to setpoints on a year-round basis. This stringency must be accounted for in all future constructions and renovations of animal housing facilities.

Temperature and pressure within the room shall be monitored in the hallway, and contained in a flush-mounted panel. Temperature alarms should provide feedback to the U-M central BAS.

Lighting, Power, Data, and Fire Alarm

Typically, illumination should be dual level with a high level of 100 to 140 fc (measured at 36" AFF with all lights on) and a low level of 50 to 70 fc (measured at 36" AFF with one half of lights on). A manual one-hour timer located just inside of the room door, under a

waterproof cover, should control one half of the lights. The other half of the lights should be controlled by the U-M central BAS. Optical sensors (photocells) shall provide feedback to BAS for the trending of both room light levels. In special rooms, one half of the lighting may require red lamps or standard lamps with red covers.

Provide waterproof lighting fixtures to prevent entry of insects and water spray from wash-down hoses. Electrical receptacles shall have waterproof covers, and may need to be explosion-proof. Provide GFCI receptacles in all areas subject to wash-down or within 6 feet of sinks.

Provide data jacks with waterproof covers in each animal housing and procedure room. Provide sufficient wireless points for complete coverage of animal facility. Review wall phone locations with Design Manager.

Provide waterproof fire alarm devices in all areas subject to wash-down. For animal suites that house mice or other small rodents, the fire alarm audible sound shall be a Temporal Code 3 slow whoop with a peak frequency of less than 500 Hz. If the building is a high rise, the Code-required evacuation message shall also be less than 500 Hz. Contact the AEC Electrical Department through the Design Manager for the latest recommendation on audible devices. Fire alarm visual devices (strobe lights) shall be located in corridors only because animal rooms are not considered public or common spaces.

Standby Power:

Standby power may be critical to maintain animal health in a power outage, especially in locations using ventilated racks. Early in the design process, review the following considerations with the Design Team:

- Need for standby power including, how much power, how quickly, and for how long.
- Specific loads requiring power.
- Spare capacity of existing generators.
- Ability to add a generator, including available space, available fuel, and exhaust, noise and vibration impacts.
- Cost impact on the project.
- Alternatives, such as moving the animals elsewhere, connecting a portable generator to the building within a few hours, etc.

Plumbing

Animal rooms should have hot and cold water and a stainless steel wall sink with a drain board. Heavy water use areas should have hot and cold water hose bibs located under the sink.

Floor drains capable of being capped (4") are desirable in all rooms, but may be excluded in certain circumstances. Heavy water use areas shall have the floor sloped 1/4" per yard and contain rim-flush drains. Drains should have locking covers and contain a bucket trap.

Large animal rooms have special plumbing requirements (eg., trench drains, flush drains).

Determine whether an automated animal drinking water system is required.

Operating Rooms

Operating rooms cannot be used as offices, laboratories, or storage rooms.

Air from operating rooms shall be 100% exhausted. Supply and exhaust grilles must be located to provide proper airflow within an occupied room. Typically non-aspirating (perforated) supply air diffusers should be selected and located so that incoming air does not disturb the natural thermal plume that develops over the surgical site. The room shall be maintained at a positive pressure with respect to the adjacent preparation area or corridor.

Typically provide the following:

- Surgical light
- Easily sanitized surgical table
- Appropriate scavenging vacuum or alternate means of gas exhaust
- Plumbed oxygen from a central tank location
- Hot and cold water
- Explosion-proof electrical receptacles and conductive flooring if explosive anesthesia is used

Surgical Support Rooms

Provide at least 2 surgical support rooms separate from the operating room. One is for surgeon preparation, and the other for animal preparation. The former may also be used for instrument and pack preparation and the latter for post-operative recovery. However, prolonged and complex post-operative recovery should be performed in a recovery room separate from both the surgeon preparation room and the animal preparation room. The surgeon preparation room should be contiguous with the operating room; whereas the animal preparation room need not be. Provide an autoclave in close proximity.



LOADING DOCKS

Scope

Provide Loading Docks as described below and in accordance with the program requirements.

Design and Installation Requirements

Provide space for refuse containers, trash compactors, and utility carts. The specific type of refuse container or compactor shall be reviewed with the Grounds Department through the Design Manager early in the design process. Provide access for the large 34 cubic yard trucks to service the containers.

Recycling containers shall be located within the loading dock area. Coordinate with facility manager to determine size, quantity and removal schedules.

At dining facilities coordinate with Housing and Dining Services for location of extractor and required storage. Typically located within loading dock area, these elements require significant coordination and planning.

Canopies which extend beyond the edge of the dock should be installed with a minimum clear height of 13'-6" above the driveway to ensure truck clearance under the canopy, lights etc. Preferred clearance height is 14'-0". Confirm the clearance with the Design Manager. If it is not possible to achieve sufficient height, a 6" diameter galvanized and painted steel tube shall be chain hung at the leading edge of the canopy to alert drivers to impending impact. The support structure of the heads of the dock openings which are exposed to potential impact shall be sized and stabilized to withstand the impact.

Provide an overhead dock door (motorized if noted in the program statement), and an adjacent person door.

Provide dock levelers and truck restraints were required.

Provide a storm sewer catch basin in the dock well.

Provide power and control circuits to motorized door openers, dock levelers, and trash compactors. Motorized overhead doors shall have operators easily accessible for maintenance, safety beam and sensing edge safety devices, and keyed control stations inside and outside.

Provide GFCI duplex receptacles for other general purpose needs.

Provide an outdoor campus or emergency telephone and/or a card reader as noted in the program statement.

Provide photocell controlled LED wall pack or downlight outdoors to light the dock area.
Specify appropriate cut-off to minimize direct glare to vehicles and pedestrians.

Do not install fire alarm system control panels, security system control panels, time clocks or other electronic panels in the loading dock areas because of the potentially harsh environment and to avoid abuse from the materials being moved through the area.

TELECOMMUNICATIONS ROOMS

Scope

Voice and data systems for the Ann Arbor, Dearborn and Flint Campuses are provided by the U-M Information Technology Central Services, ITSComm Department. Voice and data systems for University of Michigan Hospitals and Health Care (UMHHC) facilities are provided by the Medical Center Information Technology (MCIT) Division, but UMHHC projects often include ITSComm involvement as well.

Coordinate with ITSComm or MCIT through the Design Manager and provide telecommunications rooms as described below and in accordance with the Program Documents. On new building, building addition and total renovation projects, provide additional infrastructure for a Distributed Antenna System (DAS) to propagate cell phone and emergency responder radio frequencies throughout the building.

Related Sections

Design Guideline Technical Sections:

[16010 – Basic Electrical Requirements](#)

[16050 – Basic Electrical Materials and Methods](#)

[16450 – Grounding](#)

[16740 - Voice and Data Systems](#)

U-M Master Specifications:

[260533 –Electrical Materials and Methods](#)

[272000 - Voice and Data Communications](#)

U-M Standard Details:

[16740 Series - Telecommunications Details](#)

References

ANSI/TIA/EIA-568-C	Commercial Building Standards for Telecommunications Cabling Standards
ANSI/TIA/EIA-569-C	Commercial Building Standards for Telecommunications Pathways and Spaces
ANSI/TIA/EIA-607-B	Commercial Building Grounding and Bonding Requirements for Telecommunications

Architectural Requirements

The Building Entrance (BE) room is the main termination point in a building for interconnecting cables external to the building (OSP cables) with cables internal to the building (ISP cables).

In addition, the BE may house voice/data racks, switches, routers, patch panels and terminations, DAS racks and distribution equipment, and electrical equipment of other systems. A BE may also serve as a combination BE and TR and serve local voice/data work outlets.

Telecommunications Rooms (TRs) are distribution and termination rooms that serve the voice/data work outlets in the immediate area. In addition, TRs may house voice/data racks and equipment, DAS distribution equipment and electrical equipment of other systems.

1. Locate the BE within 50 conduit feet of the telecommunication service entrance and relatively close to the TRs. Locate the TRs to allow star distribution of cabling.
2. Stack TRs vertically to provide short, direct, vertical paths for riser and network cables. See Figure 1.
3. Provide a minimum of one TR per floor. Provide additional TRs to ensure:
 - One TR for every 10,000 square feet of floor area being served.
 - One TR for every 300 voice/data outlets being served.
 - The cable distance to the farthest voice/data outlet does not exceed 295'.
4. When providing for a DAS, locate the DAS racks in the BE. Design the BE and one TR (two on floors over 25,000 square feet) on every other floor to house the DAS distribution equipment.
5. Size rooms according to the following rules:
 - Coordinate with ITSComm or MCIT to obtain the quantity and arrangement of voice/data and DAS racks in each room. Assume each rack will be 8' tall by 32.5" wide (including side-mounted cable managers) by 36" deep. See Standard Detail 16740010. Show the rack outlines on the plan drawings.
 - Size the rooms to provide the National Electrical Code minimum working space of 3' in front, 3' in back, and 2' on one side of each rack.
 - Provide backboard-covered wall space for non-rack equipment including patch panels, terminations, and other electrical equipment. Comply with NEC minimum working space requirements.
 - In rooms designed for DAS distribution equipment, designate a 6' wide by 4' tall section of backboard for the DAS.
 - When a room is not square, the minimum short wall length shall be 8'.
 - Minimum size for the BE shall be 12' x 12'. See Standard Detail 16740001.
 - Minimum size for the TRs shall be:
 - 12' x 12' for 10,000 square feet served.
 - 10' x 10' for 8,000 square feet served.
 - 8' x 10' for 5,000 square feet served.
 - See Standard Detail 16740002.
6. Minimum room height is 9'-0".
7. Leave the room ceilings open to the decks above. No ceilings are allowed.

8. Cover the walls from 6" AFF to 8'-6" AFF with $\frac{3}{4}$ inch Class B fire retardant plywood backboards (smooth side out). Backboards shall be rigidly installed. Do not paint backboards. The fire rating stamps must remain visible.
9. Paint or seal the floors. No carpeting is allowed. Provide vinyl tile flooring only when requested by ITSComm or MCIT.
10. Doors shall be 36" wide by 80" high minimum and shall swing outward. Doors should be located near a corner of the room, and shall have storage room function hardware. Doors shall not have door sills, and double doors shall not have center posts.
11. When noted in the Program Documents, provide or prepare the doors for card readers and electrified door hardware.

Mechanical/Electrical Requirements

1. Ductwork, piping, and other mechanical system components are not permitted in a BE or TR unless they serve the room.
2. Provide the BE and TR's with cooling 24 hours/day, all year around. Fan coil units located outside and ducted to the rooms are preferred. Room temperature shall be maintained between 68 degrees F (20 degrees C) and 77 degrees F (25 degrees C).
 - No room humidification or dehumidification is required.
 - Feed the cooling system with generator standby power only when the room contains DAS distribution equipment. Otherwise, feed the cooling system with normal power.
3. During project programming, assume an equipment heat load of 6,000 watts per room.
 - In rooms designed to house DAS racks or distribution equipment, add 2,400 watts.
 - Add the heat loads of other electrical equipment in the room including uninterruptible power supplies (UPSs), fire alarm panels, security panels, card access control panels, CCTV panels, and Power Over Ethernet (POE) power supplies.
 - The resultant heat loads will be worst case. Confirm the heat loads during design and reduce the cooling to match the confirmed heat loads.
4. Provide fluorescent lighting of at least 500 lux (50 foot-candles) 3' above the floor. Feed the lighting with emergency power when generator emergency power is available. Provide light switches. Time controls and occupancy sensors are not allowed.
5. Provide conduits and floor sleeves for telecommunication cables per Figure 1. Conduits and floor sleeves shall be 4", shall extend into the room 4", shall be sealed water tight, and shall be fire stopped. When providing for a DAS, provide 2 additional conduits or sleeves between the rooms for DAS cabling. Provide spare conduits and sleeves for future use.
6. Extend cable trays a minimum of 6" into the rooms.

7. Provide:
 - Dedicated 120 volt, 20 ampere circuits to duplex receptacles 48" AFF and 10' apart on the plywood backboards.
 - In rooms designed to house DAS distribution equipment, two dedicated 120 volt, 20 ampere circuits to quad receptacles on the DAS backboard.
 - Dedicated 120 volt, 30 ampere circuits to NEMA L5-30R receptacles and dedicated 120 volt, 20 ampere circuits to power strips on the voice/data racks and DAS racks. See Standard Detail 16740010.
 - One 120 volt, 20 ampere circuit to a duplex convenience receptacle on the wall near the door.
8. Coordinate all receptacle locations with ITSComm or MCIT. Feed the voice/data racks and backboard receptacles with generator standby power only when the voice and data system is required to support life safety functions. Feed the DAS racks and DAS backboard receptacles with generator emergency power. Feed the convenience receptacle with normal power.
9. Provide a 1" x 12" x ¼" thick copper ground bus bar in the BE and each TR. Connect it to the unit substation room ground bus bar and to the ground bus bars in the receptacle panels feeding the BE and TR receptacles. Use No. 6 AWG green insulated, stranded, copper ground cables. The resistance to building ground shall be 1 ohm maximum.

Division of Responsibilities

The following BE and TR equipment will be provided by others.

- Voice/data and DAS racks and cable managers.
- Ladder-type cable racks above the voice/data and DAS racks.
- Uninterruptible power supplies (when required).
- Telecommunication and DAS equipment, patch panels, cables, splice boxes and terminations.

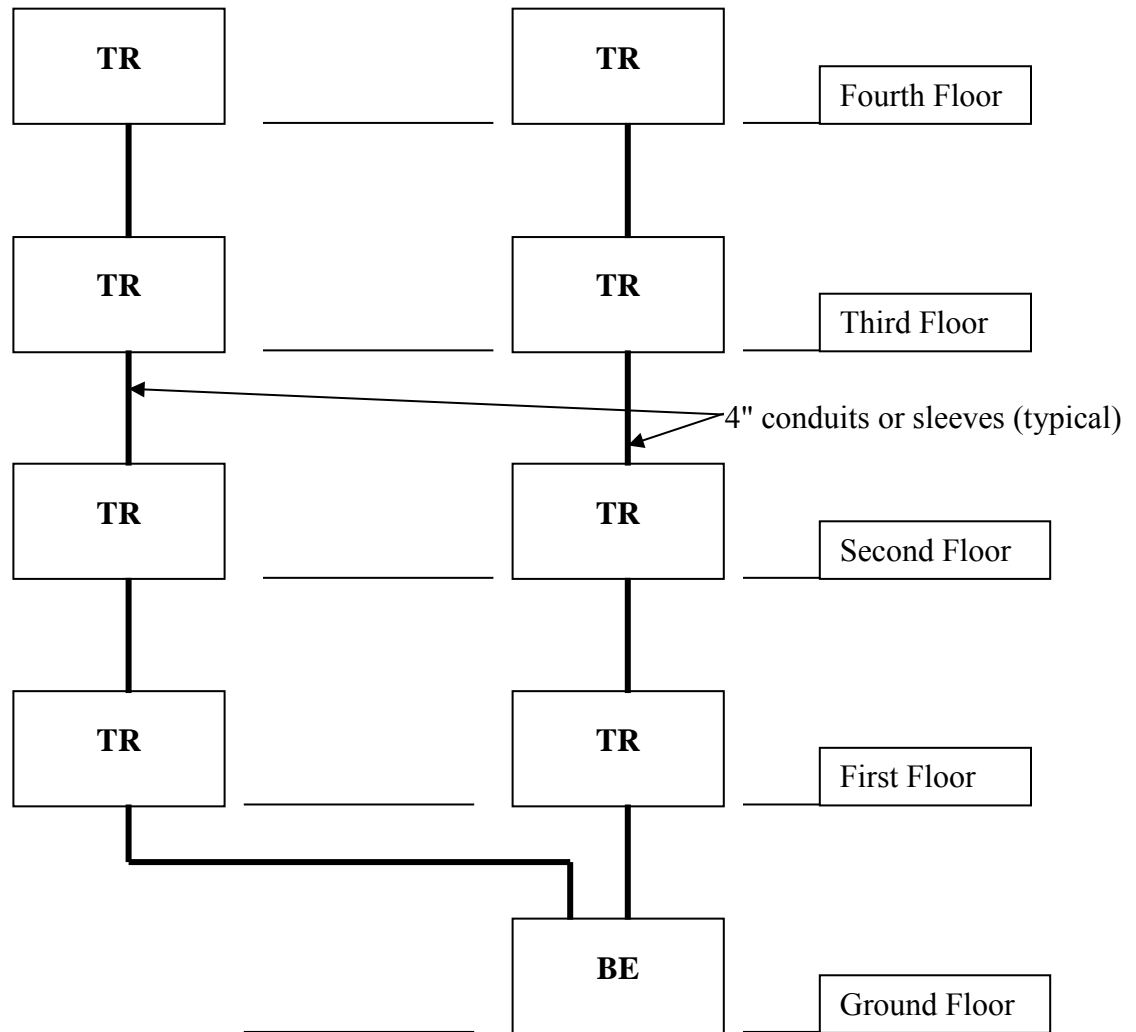


Figure 1 - Typical Building Telecommunications Room Riser Diagram
No Scale

SBA-C-H: REQUIREMENTS FOR TELECOMMUNICATIONS ROOMS

General

This SBA documents all of the specific requirements for telecommunications rooms and like infrastructure for University of Michigan Hospitals and Health Centers (UMHHC) facilities. This document completely supersedes SBA-C in all UMHHC owned and long term leased facilities.

New buildings shall provide telecommunication infrastructure in full accordance with this document. Major renovations in existing buildings shall, when noted in the program statement, upgrade the telecommunications infrastructure also in full accordance with this document.

All voice and data systems services in UMHHC facilities are provided by the Medical Center Information Technology (MCIT) Division of UMHHC. Also, in almost all cases, UMHHC projects include AT&T (under MCIT separate contract) for wire pulling and similar services.

In some cases U-M (Campus) Information Technology Services (ITS) also has involvement as well. In these cases there will be specific notation in the project scope statement noting their involvement and to what degree.

Coordinate through the Design Manager for the specific MCIT requirements for each project and provide telecommunications rooms as described below and in accordance with the Program Documents.

Related Sections

Design Guideline Technical Sections:

[SID-F-H](#) – “Supplemental Codes and Regulatory Agencies”

[260500-H](#) – “Supplemental Common Work Results for Electrical”

[260526-H](#) – “Supplemental Grounding and Bonding for Electrical”

[260533-H](#) – “Supplemental Electrical Materials and Methods”

[260543](#) – “Underground Electrical Services”

[260553-H](#) – “Supplemental Electrical Equipment Identification”

[272000-H](#) – “Supplemental Voice and Data Communications”

[E-PML](#) – “Electrical Preferred Manufacturers List”

References

ANSI/TIA-568-C	Commercial Building Standards for Telecommunications Cabling Standards
ANSI/TIA-569-B	Commercial Building Standards for Telecommunications Pathways and Spaces
ANSI/TIA-606-A	Administration Standard for Telecommunications Infrastructure of Commercial Buildings.
ANSI/TIA-607-A	Commercial Building Grounding and Bonding Requirements for Telecommunications
ANSI/TIA-758-A	Customer-Owned Outside Plant Telecommunications Cabling Standard
ANSI/TIA-1179	Healthcare Facility Telecommunications Infrastructure Standards
BICSI – TDM	Building Industries Consulting Services International - Telecommunications Distribution Methods Manual.
ASHRAE	HVAC Applications, Chapter 19, 2011 – Data Processing and Telecommunications Facilities

UMHHC Definitions:

BE - Building Entrance

Building Entrance (BE) Room is a space that combines the functionality of two telecommunication industry standard spaces defined 1) Entrance Facility (also known as Main Distribution Frame -MDF) and 2) Equipment Room (also known as Main Telecommunications Room or Building Distribution Frame - BDF).

BE Room is the telecommunications service entrance to the building and main equipment room. This room is the main demarcation point for interconnecting cables external to the building (OSP cables) with cables internal to the building (ISP cables). It is a central space for telecommunications equipment that serves some or all building occupants. It contains the electronic equipment that transition between the core data, voice, and video backbones and the building backbone, patch panels, terminations, equipment racks, telephone switches, and other electronic equipment that servers the building.

TR - Telecommunications Rooms

Telecommunications Rooms (TR) are distribution and termination rooms that serve the user stations (work area outlet) in the immediate area of the TR. It is where the connections are made between the horizontal cabling to the outlets is made to the building vertical/backbone cabling occurs. TRs also house voice and data equipment, and auxiliary electrical equipment of other systems such as nurse call, fire alarm, etc.

Backbone (Riser) Cabling

The vertical cabling distribution system that provides connection between telecommunication spaces such as BE and TR.

Horizontal Cabling

The cabling between the TR and the Work Area (work area outlet) that carries voice, data and video signals.

Work Area Outlet

Any point of connectivity for voice/data/CATV and like services. These typically are at the user end (i.e. work area, desk, etc.).

Telecommunications Pathways

Conduits, cable trays or other supports with the sole purpose of carrying telecommunications cabling. Telecommunications pathways shall not be used by other low-voltage systems, including but not limited to: fire alarm, security systems, and or building automation wiring or air/vacuum tubes.

Outside Plant (OSP) Cabling

Telecommunications cabling and terminations primarily located outside the building footprint; including but not limited to copper and optical cabling, splicing and terminations, lightning and electrical protection, and work related to their construction.

Inside Plant (ISP) Cabling

Telecommunications cabling and terminations primarily located inside the building footprint; including but not limited to copper and optical cabling, splicing and terminations, lightning and electrical protection, and work related to their construction.

Outside Plant (OSP) Pathways

Telecommunications pathways primarily located outside the building footprint; including but not limited to conduits, maintenance holes, hand-holes and work related to their construction.

MCIT

Medical Center Information Technology department provides information technology services to the entire UMHHC campus – Hospitals, on and off campus medical centers and the Medical School.

Auxiliary Electrical Systems

Auxiliary electrical systems include any number of non-power, commonly low voltage, electrically operated systems for functions such as fire alarm, security, building management (BMS), nurse call, intercom, and like systems approved by UMHHC/MCIT

MCIT Service Level for Telecommunications Rooms

Based on the area the TR serves and equipment installed within, each room is classified according to the below noted expected IT service availability and recoverability criteria. Design guidelines and this SBA will include specific power cooling and like infrastructure requirements for each service level. [Note: The response times noted below specifically relate to IT responses to failures. The infrastructure supplied to BE and TR rooms should be configured to allow building and operational personnel the tools and systems to respond in a similar manner.]

Bronze

Standard Class Service – Monday to Friday, 8 am to 5 pm operations.

Silver

Business Class Service – Monday to Saturday, 7 AM to 7 PM operations.

Gold

High Availability Environment – 24/7/365 operations.

Platinum

High Availability & Patient Safety Environment – 24/7/365 operations.

Note: As noted below, BE rooms typically are Platinum

General Requirements:

If not clearly stated in program statement, ask the Design Manager for the 'Service Level' standard required for the telecommunications infrastructure to be installed. For programing purposes, assume Platinum service level for inpatient & ambulatory surgery occupancy and assume Gold Service Level for outpatient / business occupancies. Building Entrances shall typically be considered Platinum Service Level.

Drawings shall clearly identify areas in each communication room dedicated for the IT services being installed as well as for each auxiliary electrical system being installed. Provide plans and elevations to clearly define location (typically wall space), heights, etc. to insure maximum available resource (space, etc.) is maintained for future changes.

Consider and show space (in plan views) for, working clearances needed for maintenance and operation, and code mandate clearances for all current and known future equipment planned for the room. Also provide and show the power and cooling infrastructure needed to support the entire room.

In existing buildings where a central UPS is present, and in new buildings where a building-wide UPS is part of the program statement, provide building UPS power for IT loads in communication rooms and emergency power for room cooling, lights and miscellaneous power. When noted in program statement, provide these also for major renovations. Where building wide UPS is not present, provide power to rack-mounted UPS systems of size and number defined by MCIT

BE and TR rooms shall be secured by dedicated keys and card readers, and be dedicated to this purpose with no other building services sharing the space.

If conditions allow the BE may be co-located with one TR room, when approved by MCIT. When this is done provide room sized for both functions.

Equipment, including racks, patch panels, cable management, etc. for each room to be specified by MCIT for each project. Ask the Design Manager for the MCIT specifications for each room.

See 272000-H for detailed specifications to each item below.

Architectural Requirements

1. Locate the BE as close as practicable to the point where the telecommunication (OSP) cables enter the building and relatively close to the TRs. Preferably this is at or near the exterior wall of the facility,

and in no case more than 50' cable feet from the point of entering the building. BE room should be accessible for deliveries (close to dock), away from potential sources of EMI such as power substations or switchboards), away from machinery that causes vibration such as air compressors), and away from sources of potential water damage (i.e., steam pipes, drains, clean-outs, etc.).

2. Centrally locate the TRs to allow 'star' distribution of cabling to the user stations (work area outlets). Stack TRs vertically to provide short, direct, vertical paths for riser and network cables. (see Figure 1)
3. For critical in-patient buildings provide one BE plus a hybrid TR/BE on the ground floor, otherwise provide one BE on the ground floor. Ask the Design Manager for the specifications for each building.
4. Provide a minimum of one TR per floor. Provide additional TRs as required to also ensure:
 - a. One TR for every 10,000 square feet of floor area being served.
 - b. One TR for every 300 voice/data outlets being served.
 - c. Place the TR centrally, so the cable distance to the farthest voice/data outlet (work area outlet) does not exceed 295' cable feet. This 295-foot requirement shall include an allowance of 24" of slack at work area outlet, and 10-feet of slack at the patch panel rack in the TR.
5. These rooms shall be free of obstructions such as diagonal bracing, stairs, or other utilities. Infrastructure serving TR's & BE's shall be limited to that which directly serves the TE/ BE space. Ideally, if room shares spaces with other networked facility systems (i.e. BMS, fire alarm, etc.), the rear two thirds of the space should be devoted strictly to telecommunications and IT equipment and services. Place cooling and power equipment serving room so those equipment's are not directly above IT racks and like equipment.
6. Coordinate with MCIT to obtain the quantity and arrangement of equipment racks in each room. Allow space for a minimum of three (3) racks (each rack is 7' to 9' tall by 39" wide [including wire management troughs] by 30" deep). Show the rack outlines and needed working clearances on the plan drawings.
7. Size the rooms to provide the National Electrical Code minimum working space of 3' in front, 3' in back, and 2' on one side of each rack.
8. Provide space (including NEC minimum working space) for non-rack equipment including patch panels, terminations, and auxiliary electrical system equipment. Consider needs to co-locate non-MCIT devices (networked facility systems (i.e. BMS, security, etc.).
9. **BE** minimum size is based on the building gross square footage.

10.

Building Gross Sq. Ft.	BE Sq. Ft.
Up to 20,000	130
20,001 to 50,000	140
50,001 to 75,000	200
75,001 to 200,000	240
200,001 to 400,000	340
400,001 to 600,000	390
600,001 to 900,000	430

11. **TR** minimum size for all service areas shall be 130 sq. ft.
12. The minimum short wall length for TR and BE rooms shall be 10', rectangular rooms are preferred.
13. Minimum room height is 9'-6" clear in entire room.
14. Leave the room ceilings open to the decks above. No ceilings are allowed. Fire-proofing of overhead steel shall be sealed and/or encapsulated behind drywall.
15. Seal all concrete surfaces

16. Paint or seal the walls and cover at least 3 walls from 12" AFF to 9'AFF with 3/4 inch Class B fire retardant plywood backboards (smooth side out). Backboards shall be rigidly installed and painted per 272000-H specifications.
17. Install anti-static vinyl tile on the floors, no carpeting is allowed.
18. Doors shall be 36" wide by 80" high minimum and shall swing outward. Doors should be located near a corner of the room, and shall have storage room function hardware. Doors shall not have door sills, and double doors shall not have center posts. Consult with Security on how to key each door.
19. Provide or prepare the doors for card readers and electric hardware sets (preferred), or electric strikes.
20. Sleeves or dam walls around floor slots and sleeves shall extend 3" AFF. All slots and sleeves shall be fire-stopped.

Electrical Requirements

1. Provide fluorescent lighting per TIA/EIA-569-B Standard; typically 8.5' high providing 50 vertical foot candles @ 3' AFF. Fluorescent lighting shall not be installed directly above equipment racks. Emergency lighting and power should be provided.
2. Provide manual switches for the lighting. Time controls and occupancy sensors are not allowed.
3. Conduits and/or floor sleeves (see Figure 1) shall extend upward 3" AFF, shall be water tight, and shall be fire stopped. Provide spare sleeves and conduits for future use.
4. Extend conduits and cable trays a minimum of 3" into the rooms. Whenever possible extend the tray to an area above the proposed location of the relay racks. Also provide a cable tray over the tops of all of the racks.
5. Supply BE & TR rooms, including lighting, with emergency power (UPS & generator) when available within the building, unless otherwise specified. Cooling systems for these rooms shall be powered from emergency generator sources when generator power is in building, or part of program statement (UPS power not required).
6. If possible locate the electrical panel serving the BE or TR room within the room (dedicated) or nearby to facilitate future modifications.
7. Provide the following power at the top of each equipment rack unless specifically noted otherwise.¹ For Palatinum and Gold Service Level rooms see 'Gold and Platinum Service Level Requirements below.
 - a. 1x 30A 208V Critical (generator backed up) L6-30R outlet.
 - b. 1x 20A 208V non-critical or on a separate electrical branch L6-20R outlets.
 - c. 1x 20A 120V quad receptacle as a service outlet.
 - d. If a building-wide UPS is not available, provide 1x rack-mounted 6000V UPSs, with remote monitoring capabilities accessible by Facilities Systems Monitoring. Provide a general alarm point from the local UPS to the BMS.
 - e. Note: If generator power is not available in building see, Design Manager
8. Along all walls install 120V/20A general purpose duplex NEMA 5-20R electrical outlets every 6' at 6" AFF. This should be below the plywood backboard and not on emergency power. Auxiliary electrical systems accepted. See appropriate design guideline section for appropriate power for the various auxiliary systems.

¹ If building has a central UPS top of the rack power can be changed to 2x 20A 208V electrical circuits with at least 1 on central UPS power.

9. Include a minimum of two dedicated 120V, 20A quad outlets separate branch circuits to the top of equipment racks. When emergency power is available, one of these circuits shall be on emergency power; the other shall be 'normal' power. Also provide 1x 120V 20A horizontal rack-mounted PDU.
10. As required by Design Guideline 16050-H and 16195-H Label every electrical outlet with typed labels indicating the serving power panel and breaker.
11. Provide a ¼" x 2" x 12" copper ground bus (Panduit GB2B0306TPI-1) in the BE, and each TR room, and connect it to the building ground system, in the main substation room, using a #6 AWG or larger insulated copper ground wire. Design in accordance with the recommendations from ANSI/TIA-607-A. The resistance to building ground shall be 2 ohm maximum. Bond each rack independently to the noted above noted ground bar in the TR or BE room. Note: One # 6 may be used to serve all of the TR rooms in a vertical stack.

Mechanical Requirements

1. Ductwork, piping, and other mechanical system components (water/gas/fuel/drain/etc.) are not permitted in or through these rooms unless they serve these rooms.
2. Room temperature and humidity shall be designed per ASHRAE Handbook, HVAC Applications 2011, Ch 19; 24 hours a day, 365 days a year, maintained between 65 deg. F- 80 deg. F/ max 55%RH, positive pressure.
3. Cooling capacity for TR rooms shall be based on a minimum MCIT equipment heat load of 5,000 watts per room; plus that of all current and planned auxiliary electrical system equipment.
 - Confirm projected heating loads with MCIT during design phase. Load shall include rack mounted UPS units.
4. Provide emergency power for the room cooling system if emergency power circuits are provided in the space. The need for 24/7/365, high density, emergency powered cooling typically dictates the use of a packaged dedicated HVAC system (i.e. fan coil unit [FCU] or split DX) for each room. UMHC's standard is to utilize a chilled water FCU when an emergency source of chilled water is available (i.e. process chilled water - PCHW).
5. Ideally the FCU shall be mounted outside of the room, typically in an adjacent corridor, and ducted into and out of the space. Provide minimum ventilation air off of the central AHU for each room. If the room is large enough, or if adjacent space is too limited, locate the dedicated FCU within the room, at the door. All piping serving the FCU within these rooms, including chilled water and condensate piping, and the fan coil itself, shall be provided with an auxiliary drain pan. Pan shall not impinge on maintenance of the FCU.
6. All TR/ BE rooms shall be remotely monitored and alarmed thru the DDC BMS by UMHC Systems Monitoring. BMS shall monitor space temperature and alarm when space temperature is <65 deg. F or >80 deg. F. When a possible source of water leak exists in the room (i.e. FCU or water/ drain piping), provide a floor-mounted leak detector, located in the corner of the room out of the path of travel, integrated to alarm thru the BMS.
7. Route sprinkler piping over aisles, not directly over IT equipment. All exposed sprinkler heads shall utilize protective cages.

Bronze and Silver Service Level Requirements

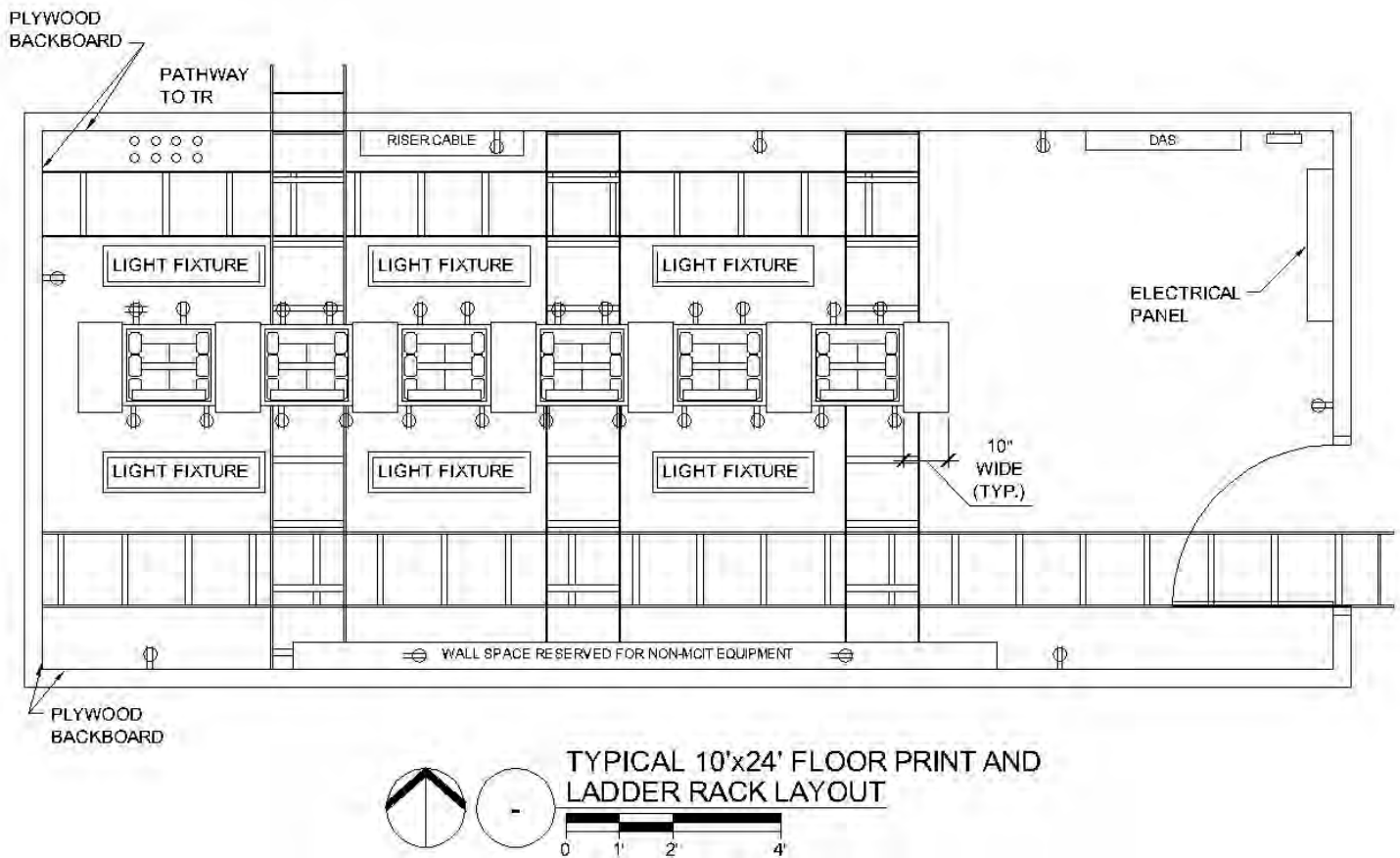
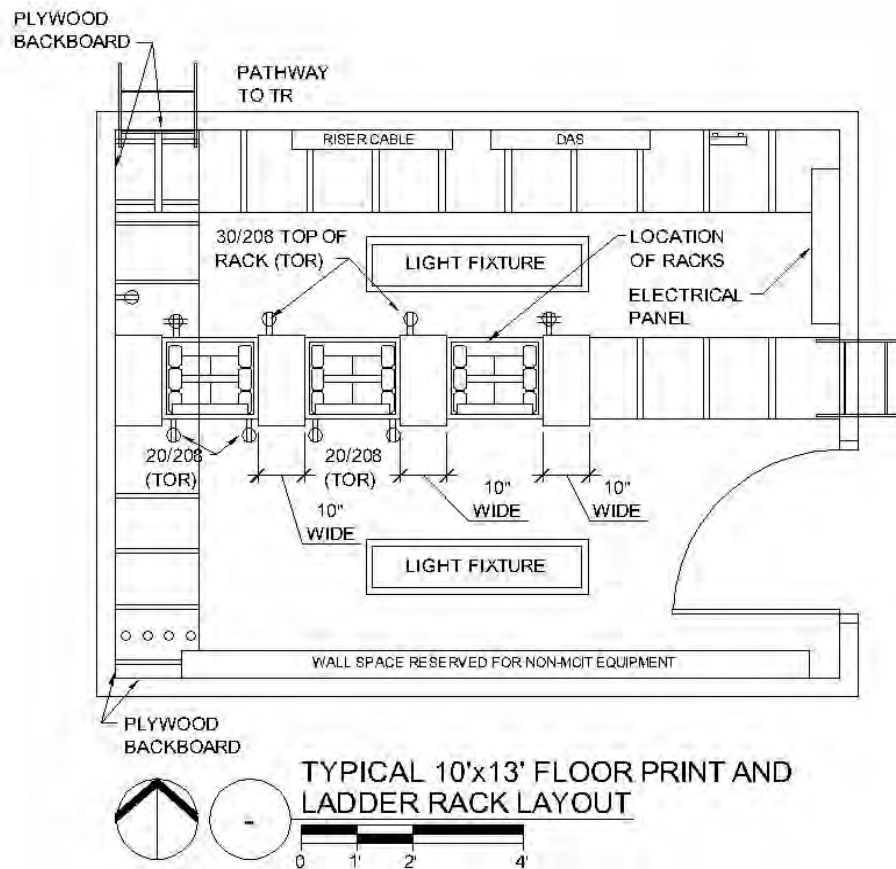
All requirements stated above.

Gold and Platinum Service Level Requirements

- 1) All requirements stated above.

- 2) Provide the following power at the equipment racks in-lieu-of those mentioned in lower service levels.²
 - a) 2x 30A 208V Critical (generator backed up) L6-30R outlets.
 - b) 4x 20A 208V non-critical or on a separate electrical branch L6-20R outlets.
 - c) 1x 20A 120V quad receptacle as a service outlet.
 - d) If a building-wide UPS is not available provide 1x floor mounted 8-10 KVA UPS or 2x rack-mounted 6000kVA UPSs, with remote monitoring capabilities accessible by Facilities Systems Monitoring. Provide a general alarm point from the local UPS to the BMS.
- 3) Cooling capacity for TR rooms shall be based on a minimum MCIT equipment heat load of 10,000 watts per room.
 - a) Confirm projected heating loads with MCIT during design phase. Load shall include rack mounted UPS units and non-MCIT devices (CCTV amplifiers, etc.) where appropriate.
- 4) Cooling capacity for BE rooms shall be based on a minimum MCIT equipment heat load of 20,000 watts per room.
 - a) Confirm projected heating loads with MCIT during design phase.

² If building has a central UPS top of the rack power can be changed to 8x 20A 208V electrical circuits with at least 4 on central UPS power.



CUSTODIAL CLOSETS

General

Provide Custodial Closets as described below and in accordance with the Program Documents.

Related Sections

For preferred room layouts, see details:

[SBA D01 5 03.pdf](#)

[SBA D02 5 03.pdf](#)

Architectural Design Requirements

Provide a minimum of 1 closet on each floor if it is a small building. In larger buildings, provide at least 2 on each floor. Place them on opposite wings (ends) if possible.

Custodial closets should not share spaces that contain mechanical equipment, exits to the roof, or equipment to which other personnel or building occupants must have access. The closets shall not contain electrical panels or any other electrical devices except for the lights and receptacles required for custodial tasks. Closets must be capable of providing the needed security for equipment that is costly.

Closets must be sized for battery powered floor polishers.

In addition to closets, provide space in the building for the storage of a 1 month supply of custodial supplies.

Mechanical Design Requirements

Provide room exhaust at 2 cfm/sf, designed for 24 hr/day operation.

Provide a cast iron slop sink.

Electrical Design Requirements

Provide fluorescent lights controlled by an occupancy sensor, electrical duplex receptacles (GFCI protected within 6 feet of sinks), and a proper receptacle for the power floor polisher.

SBA-D-H: CUSTODIAL CLOSETS

Related Sections

This document lists the requirements for Custodial Closets in UMHHC Facilities.
For an explanation of the use of these guidelines, see [“Design Guidelines for UMHHC Facilities”](#)

General

There shall be one a minimum of one Custodial Closet per inpatient nursing unit; a minimum of one Custodial Closet per floor per outpatient clinical building, as required by code, and as dictated by the program.

The Custodial Closets shall include 4-6 coat hooks, with a duplex power receptacle adjacent to the coat hooks.

The doors shall swing out, shall be as wide as practical (min. 42” wide), and shall have stainless steel door and frame protection. Provide a classroom function lock.

Typically provide 30 linear feet of sturdy shelving for paper and cleaning products; additional shelving may be required depending on the program.

Provide a wall mounted hand sanitizer near the doorway.

The room must have a minimum width of 5'-0". Provide parking for (2) two 22" x 48" carts plus vacuum cleaner, mop bucket(s) and ladder(s). Review design for new rooms with Environmental Services Director.

Provide a minimum 24" square floor sink with pop-on connectors for cleaning product concentrates. Locate the sink close to the door, so that it is accessible without having to move carts out of the way. Install mop hook clips above the sink. Provide location for rack of cleaning product concentrate bottles (typically four bottles) adjacent to the sink.

Provide adequate light, controlled by an occupancy sensor.

Provide room exhaust on a 24/7 basis.

Provide slip-resistant flooring with a fully sloped threshold at the door, and wall protection to 48" AFF, minimum. Provide full height corner guards.

PARKING STRUCTURES

U-M Related Sections

Design Guidelines:

[SBA-C – Telecommunications Rooms](#)

[SBA-F – Unit Substation Rooms](#)

[SID-F – Codes and Regulatory Agencies](#)

[14000 – Elevators](#)

[15300 – Fire Protection](#)

[16050 – Basic Electrical Materials and Methods](#)

[16120 – Wires and Cables](#)

[16231 – Engine-Generator System](#)

[16500 – Lighting Systems](#)

U-M Master Specifications:

[14210 – Electric Traction Elevators](#)

[16231 – Engine-Generator System](#)

[16313 – Indoor Single-Ended Unit Substation](#)

[16521 – Outdoor Lighting](#)

U-M PTS Specifications:

[09912 – Parking Structure Painting](#) (Obtain from Design Manager)

U-M Standard Details:

[03410 Series – Bollard Details](#) (Obtain from Design Manager)

[10400 Series – Signage Details](#) (Obtain from Design Manager)

[16500034 – Riser for 480V Power Source](#)

[16750 Series – Emergency Telephone Details](#)

General Design Requirements

The parking structure design shall incorporate the standard requirements of this Design Guideline and any Parking and Transportation Services (PTS) requirements unique to the structure.

The U-M Design Manager shall assume the responsibility for coordinating the transfer of additional information required by the design professional to and from U-M Departments.

Identify the parking structure as an „Enclosed Parking Garage“ or a „Ramp Access Open Parking Garage“ in accordance with Code. All separations from adjacent occupancies or structures shall be clearly identified.

Obtain approval from the City of Ann Arbor for all construction/impacts within the City of Ann Arbor right-of-way that support the parking structure.

Design parking structures to provide a 75 year life.

Driver visibility shall be free of blind spots at all turning points along the drive lanes.

Bumper blocks and wheel stops shall not be used.

Provide motorcycle designated parking outside of gate-controlled parking areas. Provide a dedicated entrance for motorcycles. Incorporate PTS requirements for multi-modal (bicycle, moped, etc.) parking.

Parking spaces shall be 90 degrees to the drive lanes. Each space shall be striped on the floor with 4 inch wide yellow stripes, and shall be a minimum of 8 feet 6 inches wide when measured from center of stripe to center of stripe. Provide wider spaces for special access vehicles per PTS requirements.

Provide ADA-compliant accessible parking spaces as required by code and PTS. Accessible spaces shall be striped in yellow (not blue). Accessible parking signage shall be furnished and installed directly by PTS. Do not paint accessible parking symbols on the deck.

Architectural Design Requirements

Structure

Structures shall have a live load capacity of 70 lbs./sq. ft. minimum. Provide a minimum additional 30 lbs./sq.ft. capacity at roof levels or meet the current Code requirement for snow loads, whichever is greater.

Structure decks should be constructed with precast or cast-in-place reinforced concrete double tees and 4 inches thick minimum top of tee, not including overlay. Both precast and cast-in-place structural systems shall be evaluated during schematic design. Wherever cast-in-place concrete is used for beams, parts of the deck, or other horizontal elements, provide epoxy coated reinforcing steel.

Where precast construction is used, provide galvanic anodes at shear connectors.

Decks should have a clear span of at least 62 feet wide. At grade level and below and at levels with ADA parking, provide a minimum clearance of 8 feet 2 inches from the finished floor to the underside of any building component or pipe (including lighting fixtures and fire suppression sprinklers). Above grade level, provide a minimum clearance of 7 feet 6 inches to the underside of any building component and a minimum clearance of 7 feet 4 inches to any projecting or protruding object.

Decks shall have a protective overlay of 1-5/8 inches to 2 inches latex modified concrete or micro silica flume sand on top of the precast double tees. This overlay shall not be designed as a structural member, but as a protective overlay only, and shall be able to be replaced in the future. If a micro silica overlay is selected, provide a penetrating sealer (40 percent solids, silane sealer).

Ramped floors in the structure should not exceed a 6 percent slope where vehicles park adjacent to a drive lane, and then shall not exceed a 10 percent slope for speed ramps without adjacent parking.

Interior

Provide an enclosed lobby at each elevator landing.

Lobby and stairwell doors shall be unpainted aluminum with brushed finish and safety glass vision panels except as required by Code to be fire rated. Fire rated door assemblies shall be factory painted galvanized hollow metal with safety glass vision panels of the maximum allowable dimensions. Coordinate color with PTS paint specifications. Lobby and stairwell door hardware requirements are to be as follows:

- All doors shall have quarter panel kick plates (both sides of door) and closers.
- Exterior doors shall have panic device assemblies with locks and latches.
- Interior doors shall have push/pull hardware unless otherwise required by Code.
- Provide low energy ADA compliant door operators at all ADA accessible routes into and out of the structure. Evaluate other types of automatic operators that may be required for specific PTS applications.

Provide safety glazing in lobbies and all other areas required by Code. Window sills shall be no lower than 30 inches above the finished floor. Windows should be as large as practical to provide good visibility from the outside. Perimeter windows should utilize tinted low-E glass to minimize solar heat gain.

Evaluate public safety issues that exceed code requirements, such as security cameras in stairwells and exterior glazings that provide full viewing within stairwells.

Seal all floor penetrations water tight.

Where pre-tension or post-tension construction is used, provide cast-in-place or double-cored galvanized steel sleeves flush with floor levels and concrete-filled or covered. Provide block-outs or PVC sleeves for all wall and beam penetrations.

In general, the finish on all walls, columns, and ceilings shall be white per PTS Painting Specifications. Mechanical and electrical equipment, electrical conduits, and conduit expansion joints shall not be field painted. Mask all unpainted equipment to avoid overspray. Water, gas and fire system lines shall be painted.

Paint elevator shaft interior walls with white latex ceramic wall paint per PTS Painting Specifications to insulate the shaft against heat loss and moisture damage.

Painting of floors is not required, including stair landings, stair treads, and lobby floors. Concrete stair landings, stair treads and lobbies shall have an anti slip surface consisting of a quartz aggregate sealed with either polyurethane or methacrylate. PTS will provide aggregate color and finish.

Evaluate the use of traffic topping on exposed parking levels per PTS requirements.

Protect vertical pipes, conduits and valves from vehicle damage. Protection methods shall include either steel covers painted safety yellow or galvanized steel pipe bollards filled with concrete.

Provide movable precast concrete bollards for use in controlling traffic. See the U-M Standard Details for bollard requirements.

Provide a telecommunications room. Refer to U-M Design Guidelines for room specifications.

Provide a non-public ADA accessible toilet room on the ground level.

Provide a parking structure maintenance room, preferably on the ground level. Maintenance room minimum requirements are as follows:

- Room size minimum: 500 sq. ft.
- Room depth minimum: 18 ft.
- Roll-up door minimum: 9 ft. x 7 ft. (WxH) Obtain the door specification from PTS.
- Pedestrian Door: 42 inches wide.
- Plumbing: Utility tub and janitor's sink with hot and cold water.
- Power: 4 GFCI duplex receptacles and a separate 120 volt, 20 amp compressor circuit.
- Lighting: Ceiling fluorescent lighting with occupancy sensor control.
- Heat: Heater with wall mounted thermostat to maintain room above 45 degrees F.

Entrances/Exits

If parking controls (including electronic signage, attendant booths, gates, vehicle detection loops, and Automated Vehicle Identification (AVI) equipment) are to be provided, the equipment will be furnished and installed by others and directly through PTS. Provide concrete housekeeping pads, safety bollards installed in the pads, power and communications conduits and wiring, and lighting in accordance with PTS requirements. If no parking controls are to be installed, provide conduits for power and communications for the future addition of parking controls.

If attendant booths are to be provided, they shall be a minimum of 5 feet by 7 feet and located on 6 inch concrete housekeeping pads. At least one booth shall be ADA accessible. Incorporate PTS booth and bollard cover specifications.

The structure shall have illuminated pedestrian entrances away from the drive lanes.

Signage

Provide an illuminated facility identification sign at each entrance, LED type signs over entrance and exit lanes, and a clearance pipe above each entrance in accordance with PTS requirements.

Provide facility and level identification, directional, traffic and parking control signage in accordance with PTS requirements.

Mechanical Design Requirements

Elevators

Traction elevators shall be used. Hydraulic elevators shall not be installed in parking structures.

Provide a securable ladder with slip resistant rungs to access the roof of each elevator machine room. On machine room roofs, provide appropriate fall protection as required by Occupational Safety and Health Administration regulations.

Provide rigidized stainless steel wall panels and Class I fire-rated, slip-resistant rubber flooring in the elevator cars.

Elevator hoist ways shall be heated and cooled to maintain the temperatures specified by the elevator manufacturer. Elevator lobbies shall not be heated.

Heat and air condition elevator machine rooms to maintain an ambient temperature between 55 degrees F and 90 degrees F under all weather conditions. No heating or air conditioning equipment or piping shall be located in the machine rooms, except that which serves the rooms.

Provide stainless steel elevator door headers, frames, struts, and stainless steel or nickel-silver sills.

Provide floor drains in elevator lobbies, and slope floors downward from the room and elevator doors to the floor drains.

If the elevator(s) are considered part of the parking structure's "accessible path" or if the parking structure is classified by Code as a high rise structure, then the elevators, elevator HVAC, associated lighting and receptacles shall be connected to the emergency generator. Additionally, ingress and egress from and to the elevator and between the elevator machine room and the elevator must be "safe and reasonable" as defined by the Michigan Elevator Code.

Snow Melt System

Provide a snow melt system with the chute and control equipment on the roof. Provide a concrete housekeeping pad for the system and design the structure to support the additional weight.

The snow melt system shall be natural gas fired. Size the unit to service at least the entire roof level of the parking structure. Contact the system manufacturer for electrical, water, drainage and gas pressure requirements. Verify that required gas pressure is available. Connect a control panel "trouble" output contact to the DDC panel. Provide electric heat tracing for the water supply and drain lines that are exposed to air.

Enclose the snow melt system in a wire mesh fence with sliding gates for snow melt system operation and swing gates for personnel access to the control panel. Provide a level, skid-resistant path for personnel to safely access the control panel.

Natural Gas Service

Coordinate with the local utility to provide a natural gas service large enough to serve the snow melter, generator, and any additional equipment requiring natural gas service.

Ventilation

For structure levels that require mechanical ventilation to control CO levels, provide variable speed fans controlled by CO sensors. Connect CO “high-high” alarm output contacts to the Building Automation System DDC panel.

Evaluate the need for ventilation in glass-enclosed stairways.

Controls

Unless one is available in a close-coupled building, provide a Building Automation System Direct Digital Control (DDC) panel for connection to structure systems and equipment.

Additional Plumbing

Provide one standard hose bib on each parking level outside of stair and elevator towers. Hose bibs shall be drainable for winter.

Drainage

Provide positive drainage on all decks. Provide trench drains at the bottom of ramps from the plaza or roof levels.

Drain lines shall be 4 inch minimum and shall be heat traced where exposed to air.

Elevator and stair tower roof drains shall discharge to storm drains via lines located inside of lobbies or the parking structure. Downspouts shall not discharge directly onto the roof level floor deck.

Contact the City of Ann Arbor or other Authorities Having Jurisdiction to determine sanitary and storm water drainage restrictions and requirements. These requirements may include installation of an oil separation system.

Fire Protection

Provide drainable standpipes with 2½ inch fire hose connections on each level at each egress stairway, with additional standpipes located throughout the structure such that all portions of the structure are within 100 feet of a standpipe hose connection, or as otherwise required by Code.

Standpipe risers shall be painted red. One column immediately adjacent to each standpipe hose connection shall be marked on each side with a 6-inch wide strip of reflective red tape running perpendicular to the floor, from floor to deck, and the top 24 inches of the column should be painted red. It is not necessary to mark columns located inside enclosed stairways.

Provide a fire department connection for the standpipe system as required by the Code and NFPA 14. The fire department connection shall face the street, and shall be located within 100 feet of a fire hydrant. The fire hydrant shall be located such that a temporary meter, valve, and hose assembly can be connected for use by PTS for cleaning of the structure in accordance with City of Ann Arbor requirements.

For structures that require fire protection sprinklers, provide a dry pipe system. If available, plant air should be used to pressurize the dry pipe system. The dry pipe sprinkler valve and air compressor (if needed) should be located in the maintenance room. Provide a sprinkler system electrical failsafe contact that open if the system becomes charged, and connect it to the DDC panel.

The fire protection system shall be designed with the capability of draining down a charged system into the sanitary sewer/oil separation system for proper disposal of water.

All exposed control valves for the fire protection system shall be lockable or within lockable tamper resistant boxes.

Electrical Design Requirements

Lighting

Provide the following horizontal light levels on the floor:

<u>Area</u>	<u>Minimum</u>	<u>Average</u>
• Egress routes while on emergency power:	Per Code	Per Code
• Interior drive lanes and parking spaces:	3fc	5fc
• Uncontrolled and unattended entrances/exits:	5fc	10fc
• Vehicle entrances and exits:	10fc	25fc
• Stairways and lobbies:	10fc	25fc
• Maintenance room:	10fc	25fc
• Top deck:	1fc	2fc

Note: Deviations from the light levels listed above may be necessary to meet the lighting power density (watts/sq.ft.) restrictions of ASHRAE 90.1-2007.

Light reflectance from painted ceilings and walls shall be used during calculation of lighting levels.

Provide light levels in elevator lobbies, cars, machine rooms, and pits in accordance with the Michigan Elevator Code.

Normal lighting should have an average-to-minimum uniformity ratio of not more than 4:1, and emergency lighting should have an average-to-minimum uniformity ratio of not more than 10:1. Deviations from these ratios may be necessary to meet restrictions set forth by ASHRAE 90.1

Provide exit signs to direct traffic toward exits and pedestrians toward stairs and pedestrian exit ways. Exit signs shall be vandal-resistant LED type. Do not provide battery-backed exit signs.

Select lighting fixture cut-off to minimize direct glare into driver's eyes and to limit the amount of light exiting the structure.

Fixtures shall be vandal-resistant, UL listed for wet locations, with gasketed, high impact polycarbonate lenses secured with vandal-resistant screws, and cold weather ballasts.

Fixtures should operate at 277 volts. Do not provide battery-backed emergency lights.

Evaluate use of the following fixture types. Obtain the currently approved fixture manufacturers and models from PTS.

- 4 foot fluorescent vandal resistant wraparound fixture. Fixture to be surface or pendant mounted, with two or three 32 watt, 3500 degrees K, rapid start, T-8 fluorescent lamps and cold weather (0 degree or lower) electronic ballast. UL listed for wet locations.
- Induction lamp parking garage type, surface or pendant mounted, with 3200-3500 degrees K, 80 CRI lamp rated 100,000 hours, and electronic ballast.
- Solid state lighting (SSL) fixtures. Note: LED lighting is an emerging technology and should be evaluated as appropriate fixtures become available.
- Obtain PTS approval of the fixture type selected.

Lighting fixtures in stairways, lobbies, and elevators shall be vandal-resistant fluorescent with 3500 degrees K lamps and cold weather rated (0 degrees F or less) electronic ballasts.

Lighting in stairways, elevator lobbies, maintenance rooms and the substation room shall be connected to emergency circuits.

Lighting fixtures shall be cord and plug connected, with cords secured to conduits. Provided photometric requirements can be met, lighting fixtures over parking spaces should be located at the drive lane end of the parking spaces such that the fixtures can be repaired or replaced even if parked vehicles are present.

Lighting fixtures on the roof deck shall be metal halide or the latest PTS-approved emerging technology, shoebox type, mounted on round, tapered, hinged, aluminum poles to allow lowering the fixtures for maintenance. Refer to U-M Master Specification 16521 for additional requirements. Minimum lighting levels shall be maintained, but fixture wattage and pole height may be reduced to minimize light trespass on surrounding areas.

Lighting Controls

Circuit the interior deck lighting fixtures in rows that parallel the outer walls. Provide daylighting controls to turn off rows of lights near the outer walls when the incoming daylight is adequate.

Provide photocell controls to turn off the top deck lights when the daylight is adequate.

Provide daylighting controls in lobbies and stairwells exposed to natural daylight to turn off unneeded lights when the incoming daylight is adequate.

Power

Provide an indoor, single-ended, 13.2 kV–480Y/277 volt unit substation utilizing U-M Master Specification 16315. Locate the substation on a 4 inch minimum concrete housekeeping pad in a separate room complying with Design Guideline SBA-F. Exception: If the parking structure is close coupled to a building having sufficient power to serve the parking structure, a secondary voltage feeder may be utilized. If this is done, the feeder shall have a separate meter installed of the type specified in Master Specification 16315.

Provide a natural gas fueled engine-generator in accordance with Design Guideline 16231 to supply emergency power. Propose a location indoors in a room or outdoors in an enclosure for approval by PTS. During schematic design, evaluate sizing the generator large enough to provide power to all lighting in the structure to avoid the costs of separate emergency lights, multiple automatic transfer switches, and two conduit and wiring systems.

Provide one 120V GFCI duplex electrical outlet in the elevator lobby on every level. Provide a hinged, lockable cover on the outlet.

Raceways

Conduit should be exposed, except conduits to parking controls and attendant booths shall be embedded. Horizontal conduit runs below structural beams and vertical conduit runs should be located near columns and away from drive lane areas. Conduits located where they may be struck by vehicles shall be guarded.

Exposed conduits shall be Schedule 80 PVC and embedded conduits shall be Schedule 40 PVC, both with matching fittings, expansion fittings, and weatherproof junction and outlet boxes. Structural support channels shall be fiberglass with fiberglass or stainless steel hardware.

Exposed ½" and ¾" conduits shall be strapped to the structure with Carlon "Snap Strap" sliding clamps every 3 feet maximum. Exposed 1" through 2" conduits shall be strapped to the structure with Carlon "Snap Strap" sliding clamps every 5 feet maximum. Conduits 2" and smaller shall not be suspended on hangers. They shall be installed so no gaps exist between the conduits and the structure large enough for someone to grip the conduits and pull them down.

Exposed conduits larger than 2" shall be strapped with standard 2-hole PVC clamps, but the clamps shall be spaced off of the structure or hanger by a nylon or PVC washer under each hole of each clamp. The washers shall be thin enough so the 2-hole clamps continue to provide conduit support, but thick enough so the conduits slide through the clamps during conduit expansion and contraction.

Expansion fittings shall be provided in sufficient quantities to accommodate the expansion and contraction of a 120 degree F temperature change. Expansion fittings shall be provided within 3 feet of lighting fixtures and within 5 feet on both sides of bends and elbows. Expansion fittings shall be installed expanded or contracted as appropriate for the specific temperature existing at the time of installation.

Drain holes 1/4" in diameter shall be drilled in the bottom of exposed junction and outlet boxes.

Fire Alarm

Provide a fire alarm system only when and where required by Code. Provide fire alarm devices that are UL listed for the environment in which they will be located.

Fire alarm junction boxes, covers and fittings shall be painted red or installed in red conduit throughout. Exception: The fire alarm raceways exposed in finished areas may be painted to match wall color.

Sprinkler system water flow and trouble alarms must be monitored in accordance with Design Guideline 16720. In parking structures without a fire alarm system, the sprinkler water flow and trouble alarms shall be monitored directly through the campus MOSCAD system. Monitoring of water flow and trouble alarms in Hospital parking structures by the UMHHC Facilities Control Center may also be acceptable, in accordance with direction received from the Design Manager.

Emergency Telephones, Elevator Telephones, and Data Connections

Provide DDC monitoring and alarms in the BAS Operations Center for snow melt system trouble, exhaust fan running and shutdown, CO "high-high" level, VSD trouble, generator running and trouble, automatic transfer switch transfer to generator power, loss of natural gas pressure, sprinkler system water flow and trouble, heat tracing trouble, and trouble from any other mechanical or electrical systems.

Provide U-M standard wall-mounted emergency telephones with integrated blue lights. Kiosk-style telephones shall not be used. Provide power and communications conduits and wiring for the emergency telephones. The lights operate on 120V power. Consult the U-M Standard Details. Some redesign may be required because the existing standard details may not always apply. Installation locations shall provide for maximum visibility and accessibility.

Provide one communication line for each elevator that will serve as the emergency telephone service from the elevator to an outside monitored source. In addition, provide one telephone line for use as a modem line for each group of elevators. All communication lines must terminate in junction boxes in the elevator machine room.

Provide conduit and cable from the telecommunications room for data circuits to be used for gate control systems, programmable signage and other applications.

Provide conduit and cable from the telecommunications room to the substation for recording power meter communications.

UNIT SUBSTATION ROOMS

General

This guideline applies to rooms that contain medium voltage unit substations, and as appropriate, to rooms with large transformers, large power panels, emergency power distribution equipment or central UPS systems.

Related Sections

Design Guidelines:

[SID-F – Codes and Regulatory Agencies](#)

[16010 – Basic Electrical Requirements](#)

[16050 – Basic Electrical Materials and Methods](#)

[16110 – Underground Electrical Service](#)

[16450 – Grounding](#)

[16500 – Lighting Systems](#)

[16720 – Fire Alarm System](#)

[16950 – Electrical Acceptance Tests](#)

U-M Master Specifications:

[16313 – Pre-Purchase of Indoor Single-Ended Unit Substation](#)

[16314 – Installation of Pre-purchased Indoor Single-Ended Unit Substation](#)

[16315 – Indoor Single-Ended Unit Substation](#)

[16316 – Indoor Double-Ended Unit Substation](#)

References

International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines
NESC, “National Electrical Safety Code”

Architectural Design Requirements

Separate the substation room from occupied areas or provide sound-proofing so the 60 Hz hum cannot be heard in occupied areas.

Separate the room and large secondary feeder circuits leaving the room from occupied areas and from areas containing computers, computer servers, telecom equipment, electronic instruments and other electronic equipment which could be affected by electromagnetic fields (EMF).

- The most stringent human EMF exposure limit is published by the ICNIRP. Their published maximum limit is 833 mG. University studies have shown that EMF greater than 833 mG is possible on the face of the transformer enclosure, but that five feet away EMF has not been measured greater than 228 mG.
- University studies have shown that substation transformers and secondary feeder circuits 400 amps and larger can produce EMF of sufficient strength to impact nearby electronic equipment. Route large secondary feeders away from electronic equipment.

Extend the walls from the floor to the deck above. CMU block walls are recommended for noise mitigation and safety. Obtain permission through the Design Manager before providing gypsum board walls. Chain link fence or expanded metal walls and gates are not acceptable.

Provide a minimum of 5 feet clear above the substation primary switches and secondary switchgear. Obtain approval of primary and secondary conduit and cable tray routes and installation details before providing less clear space above this equipment.

Where required by code, provide fire-resistance rated walls and doors.

Provide the NEC-required working spaces on all sides of each piece of equipment. Provide the NEC-required dedicated equipment space above each piece of equipment. These spaces shall be free of obstructions and grounded surfaces including columns, ductwork, piping, electrical panels, lighting, ground bus bars, floor drains and water leak detectors.

Exit doors shall swing outward from the room. Provide a minimum of two exit doors on opposite ends of the room if the room contains electrical equipment rated 1200 amps or more.

- Exit doors shall be equipped with panic bars, gaskets and bottom edge door sweeps. Double doors require only a single panic bar. Door locks shall be keyed with Arrow "L Series" cores.
- One door shall be large enough for the passage of the largest shipping section of the substation. Typically, this means a minimum 8 foot tall by 7 foot wide double door.
- Where two or more doors are provided, the others may be single doors. These doors should be a minimum 36 inches wide.

Slope the floor toward the floor drain. The floor drain shall be the low point of the floor.

Provide a 4 inch minimum housekeeping pad under each piece of floor-mounted equipment.

- Pads shall conform to the footprint of the equipment and shall be the full width and depth of the equipment, but shall not extend beyond the equipment by more than 4 inches. Pad edges shall be chamfered.
- Pads shall be smooth and level within 1/8 inch overall, or shall include embedded steel leveling channels that are level to within 1/8 inch overall. Leveling channels shall have a 1/8 inch reveal above the top of the concrete and shall be located directly under the equipment support points. Pads that fail to meet these criteria shall be corrected before installation of the equipment.

Provide 2 coats of water-borne epoxy paint over a compatible primer on the concrete floor.

Provide paint or a concrete sealer on the walls and ceiling.

Provide a 10 pound Type ABC fire extinguisher at each exit door.

Provide an unobstructed route to the building exterior to permit replacement of the largest shipping section of the substation. Design the floor of the entire route for the weight of the largest transformer.

Mechanical Design Requirements

The NEC limits substation room access to Plant Operations High Voltage Electricians, making it difficult for others to perform maintenance inside the room. Avoid locating mechanical equipment including fans and fan coil units inside the room.

Ductwork, piping, clean-outs, and other mechanical system components are not permitted in the room unless they serve the room. When there is no alternative to installing foreign ductwork or piping in the room, provide an architectural barrier to segregate the foreign ductwork and piping from the room.

- Provide a minimum of a gypsum board barrier to segregate foreign ductwork.
- Provide a minimum of a waterproofed light weight concrete barrier to segregate foreign piping. Gypsum board barriers or drip pans are not acceptable to segregate foreign piping.

Provide wet sprinklers if the building will be sprinkled.

- Locate the sprinkler heads and route the piping over aisles, not over the electrical equipment.
- Provide wire guards on the sprinkler heads.

In below-grade substation rooms, provide a floor drain at the low point of the room floor. Locate the floor drain in front or behind the middle of the substation and tight to the front or rear wall. Provide a backwater check valve for the floor drain. The backwater check valve shall be located outside of the room.

When a floor drain is provided, provide a water leak detector adjacent to the floor drain and tight to the wall so it isn't a trip hazard. The leak detector shall be outside of the working space of the substation. Connect its alarm contact to the nearest Building Automation System DDC panel.

Provide ventilation to remove equipment heat and maintain equipment within their ambient temperature ratings under all weather and electrical load conditions. Typically, provide supply and exhaust fans with variable speed control to maintain the setpoint temperature. Avoid discharging unheated outside air directly into the room, which can freeze sprinkler lines. Mix return air with outside air so that tempered air above freezing is discharged into the room.

- Design for a summer design space temperature of 10 degrees F over outside ambient.
- Design for a year-around setpoint temperature of 70 degrees F (knowing the summer space temperature will rise to a maximum of 10 degrees F over outside ambient).
- Base cooling load calculations on actual equipment heat rejection data and on the projected peak diversified load for the next 10 years.
- Design the supply and exhaust to produce a slightly positive room.
- Filter the supply air to the room. Minimum filter efficiency shall be 65 percent.
- Air condition the room only if the room cannot be ventilated with outside air. If building chilled water is used, verify the chilled water system operates all year long.

Electrical Design Requirements

Avoid locating electrical equipment requiring maintenance by others in the room, including general lighting and receptacle panels, central UPS systems, Building Automation System DDC panels, fire alarm control panels, security panels, or MOSCAD panels.

Avoid locating emergency or standby power system equipment including transfer switches and panels in the room. This equipment may be required by code to be in a separate room with not less than 1-hour fire-resistance-rated fire barriers and ventilation to and from the exterior.

Provide a 1/4 inch x 2 inch solid copper ground bus bar on the wall behind each substation. Extend it the full length of the substation and mount it 18 inches AFF. Connect multiple ground bus bars together using #4/0 AWG copper ground cables. Do not wrap ground bus bars around the room doors.

- Connect both ends of each substation internal ground bus bar to its room ground bus bar using #4/0 AWG copper ground cables embedded in the housekeeping pad and floor. Connect the internal ground bus bars of other equipment to the room ground bus bar in the same manner.
- For renovation projects only where the floor is not being cut, connect the substation ground bus bar to the room ground bus bar by routing the ground cables overhead.
- Connect the room ground bus bar with #4/0 AWG copper ground cables to all available grounds including the ground grid, concrete-encased foundation rebar, building steel, incoming water services, duct bank ground conductors, lightning protection ground rods, and the ground bus bars in other electrical rooms in the building.

Terminate the incoming primary duct bank with end bells that are embedded in and flush with the inside of the room wall, and as high off of the floor as possible. Slope the duct bank away from the room. If a duct bank must enter the room from below floor level, stub it up along the inside of the wall. Obtain permission through the Design Manager before stubbing ducts up into the bottoms of the primary loop switches.

Provide 24 inch wide aluminum ladder-type cable trays with 24 inch minimum radius fittings to route the primary cables up the wall and across the ceiling of the room. Locate the trays 3 feet minimum above the primary switches, but low enough to permit cable pulling. Provide cable tray roll-outs where the cables drop down into the primary loop switches.

Provide O-Z Gedney No. R4001BO strain relief fittings where the primary cables enter the tops of the primary loop switches. Specify that the Contractor coordinate with the Utilities and Plant Engineering High Voltage Engineer (734 615-4468) or the Plant High Voltage Shop (734 615-5279) before installing the cable trays.

Provide fluorescent lighting in front of and behind each substation, and in front of other electrical equipment. Connect this lighting to emergency power. Provide a battery-backed lighting fixture or an emergency lighting battery pack in front and behind each substation. If emergency power is not available, provide battery-backed lighting fixtures or battery packs throughout the room.

Provide exit signs above the exit doors.

Label the outsides of exit doors "DANGER - HIGH VOLTAGE - KEEP OUT".

Provide duplex receptacles and connect them to emergency power.

Provide one hard-wired IT data connection to each substation watt-hour meter.

To facilitate Building Automation System monitoring of electrical power system status, connect the following devices to a DDC panel.

- Status contacts of main and tie circuit breakers in double-ended unit substations.
- Integral power metering units of the limited number of circuit breakers being monitored by BAS.
- "On generator power" status contacts of automatic transfer switches.

Provide fire alarm system rate-of-rise heat detectors and one combination audible/visual appliance in accordance with Design Guideline 16720.

Provide framed copies of the building's One Line Diagrams and Riser Diagrams on the wall in front of the unit substation.

PERSONAL ROOMS

General

During the programming phase for each new building or major renovation project, perform an assessment of the necessity of providing personal rooms for lactation, health needs and other special personal uses requiring privacy.

Consider the following:

- Projected staff, faculty, and student needs.
- Proximity and suitability of existing accommodations in adjacent buildings.

If included in the project, locate personal rooms in a space that is not a restroom and is accessible to all building occupants. Space can be shared with other compatible program elements. Review access provisions and security requirements with Design Manager.

Minimum Standards for Personal Rooms

Personal rooms included in the project shall meet the following minimum standards:

- Door which can be locked from the inside and includes occupancy indicator. In collaboration with the Design Manager and user, review the specific operation of the lockset, including consideration if it should revert to locked or unlocked state if the latch is retracted.
- If room contains windows, provide blinds, shades or other accommodations to prohibit views into the room.
- Electrical outlets.
- Acceptable environmental requirements (heating, cooling, lighting, etc.) equivalent to what is provided in other occupied areas of the building.
- Size room to accommodate at least a comfortable chair and table (to be provided by client). Alternatively, provide a shelf, minimum 12" deep, in lieu of the table.
- Access to a clean sink. If a sink is not provided in the room, a clean sink should be available nearby.

Optional Features

Review the following optional additional amenities with the Design Manager:

- Sink.
- Additional electrical outlets and space to accommodate the following Owner provided equipment:
 - Small refrigerator
 - Microwave for sterilizing equipment
 - Electric breast pump.
- Telephone and data jacks.
- Signage which includes a sign-up schedule for the room.
- Electronic access control - keypad stand-alone battery operated unit or card reader connected to central access control system.

TUNNELS

General

The University of Michigan central campus has an extensive array of tunnels used for distribution of utilities, primarily from the Central Power Plant. This section identifies key design considerations for tunnel related projects.

All work in or near tunnels must be coordinated with the Utilities and Plant Engineering (UPE) – Tunnels Department, in conjunction with the U-M Project Coordinator.

All tunnel related projects shall be designed with the long-term serviceability and maintainability in mind.

Phasing and sequencing is a primary consideration for virtually all tunnel projects, due to the fact that systems operate year-round and disruption to utilities directly impacts U-M's core mission. Proposed design alternatives should consider phasing and sequencing to minimize near and long-term interruption of utilities. Construction documents must clearly define phasing and sequencing requirements. Designs must incorporate all necessary work (valves etc.) to achieve this plan.

Related Sections

Special Instructions to Designers:

[SID-J – University Provided Utilities](#)

Design Guideline Technical Sections:

[01141 – Tree Preservation](#)

[02215 – Soil Erosion and Sedimentation Control](#)

[15060 – Basic Piping Materials and Methods](#)

[16050 – Basic Electrical Materials and Methods](#)

[16500 – Lighting Systems](#)

U-M Master Specifications:

[15060 – Basic Piping Materials and Methods](#)

[15100 – Valves](#)

[15125 – Expansion Joints](#)

[15250 – Mechanical Insulation](#)

[15525 – Steam and Condensate Piping Systems and Specialties](#)

[16050 – Basic Electrical Materials and Methods](#)

Tunnel Types

Standard Utility Tunnel: Most of the tunnel system consists of racked utility piping on one side and a walkway on the other. Some include piping on both sides. Construction of existing tunnels includes poured concrete, pre-cast concrete, and brick. Typical dimensions are approximately 7 feet wide x 7 feet high, although size must be assessed on a project specific

basis. Tunnel should be walkable, and allow for removal and replacement of valves, expansion joints etc. Tunnels are accessed through buildings or through sidewalk hatches.

Utility Tunnels Running Through Buildings: While most of the utility tunnel system is “outside”, i.e., beyond the footprint of buildings, tunnel services continue through several buildings on campus. Special care is required in designing and installing these projects to ensure tunnel security is maintained, and to ensure piping is properly designed. Minimal connections should be made to the Utility main.

Box trench: Where cost of a standard tunnel cannot be justified, box trenches, and crawl trenches are occasionally used. Access and maintainability must be considered.

Direct Buried Piping Conduit Systems: Direct buried piping is used in some locations for utility piping. Use of a conduit system for utility piping must be approved by UPE.

Building (non-utility) Tunnel: Some buildings contain “non-utility” tunnels that fall within the footprint of a building and serve only the building it is under. Building tunnels should be treated the same as building mechanical rooms, and don’t typically require coordination with the UPE-Tunnel department.

Tunnel Piping Utilities

The tunnel system was designed for the following piping utilities that emanate from the Central Power Plant: Low Pressure Steam, Medium Pressure Steam, Steam Condensate, Hot Water and Hot Water Return, and Compressed Air. These systems are operated and maintained by the UPE – Tunnels department. While most pipe materials, and design considerations for these systems are described elsewhere in the U-M Design Guidelines (Technical Section 15060) and U-M Master Specification Sections 15060 and 15100, considerations unique to the application of these systems within the tunnel system are noted below each system, or in paragraphs that follow:

- Low Pressure Steam (LPS) – operating pressure of 6-12 psig
 - While normally saturated, due to the fact that LPS is a byproduct of the co-generation steam turbines, this system experiences occasional temperature excursions. Temperature of the steam can reach 600F if the desuperheater fails. As such, all LPS piping in the tunnels shall be designed for expansion associated with 600F piping. Cast iron fittings are prohibited.
 - U-M maintains a flow model for the LPS distribution, and as such, generally defines required pipe sizes for LPS piping in the tunnels.
 - Use float and thermostatic (F&T) traps on LPS. Do not connect LPC from traps directly to the tunnel LPC system. Use condensate return unit to pump into the LPC main.
- Medium Pressure Steam (MPS) – operating pressure of 60 psig nominally

- Pressure Reducing Valves are used in some locations from the MPS system to the LPS system, for back-up and pressure maintenance during peak conditions. Associated relief valves should be routed to a safe location outside the tunnel. Refer to SID-J for additional discussion on requirements for PRV's and back-up steam.
- Steam Condensate Return (LPC)
 - The steam condensate is typically metered at individual buildings, and pumped into the LPC. While the system is under some backpressure at certain points, it is generally considered to be a low-pressure gravity return system. Do not directly connect LPC from building loads or drip and traps to LPC main. Use condensate return unit.
 - Drip and traps from MPS should not be routed directly to the LPC. Use flash tank and pumped condensate return unit.
 - Condensate return units (CRUs). A combination of electric and pressure powered CRUs are used in the tunnels.
- (Domestic) Hot Water (HW) and Hot Water Return (HWR)
 - Existing piping is primarily Type-L grooved copper piping using Victaulic fittings. U-M has an ongoing program to replace remaining steel piping with copper. Unless directed otherwise, use grooved copper piping for all DHW and DHWR in tunnels.
 - U-M has experienced numerous problems with expansion joints in HW and HWR systems. Refer to U-M Master Specification 15125 – Expansion Joints for current specification requirements.
 - All flexible piping on HW and HWR shall be of all stainless steel construction. Ball valves on HW and HWR shall have stainless steel body and ball.
 - Because of hydraulic and maintenance problems within the DHWR system, all new buildings are required to have their own internal DHWR system, typically with a small shell and tube heat exchanger and pump to reheat the DHWR back to 125F. For existing building connections, where practical, connections to the tunnel DHWR system should be eliminated, and replaced with an internal return system.
- Compressed Air (CA) – operating at 90-100 psig (refer to SID-J for clarification)
 - For building take-off, include two check valves installed in series to protect tunnel piping from possible contamination, and to protect the building

compressed air loads from sudden loss of pressure if compressed air is turned off.

Other Piping Considerations

Piping Expansion and Stress Analysis:

For new connections to tunnel piping, analyze piping expansion and stress, and anchoring forces up to and including first anchor on either side of new connection. Provide pipe stress calculations to prove new and existing piping is not overstressed.

Three Valve Arrangements for Building Take-Offs:

In general, branch take-offs for individual buildings should include a three valve arrangement, to allow the building to be fed from either direction in the utility loop.

B31.1 Requirements:

Refer to Master Specification Sections 15060 – Basic Piping Materials and Methods and 15525 – Steam and Condensate Piping Systems & Specialties for B31.1 welding requirements on utility piping.

Insulation:

- Aluminum jacketing is required on all insulated LPS, LPC and MPS piping in tunnels. Refer to Master Specification Section 15250 - Mechanical Insulation for materials and required thickness.

Other Piping and Utilities in Tunnels

The following services are not considered Utility Piping. Coordinate with UPE-Tunnels prior to routing these systems through tunnels.

Chilled Water (CHW): Chilled water is not generally distributed via the tunnel system, although CHW piping is routed between buildings, through the tunnels in several areas. Additional insulation will be required within the tunnel.

Fire Protection Water: In some locations, fire protection piping may be routed through the tunnels, especially where a fire pump is shared between buildings.

City Water, Sanitary, and Storm: Beyond the building footprint, these services are generally owned and maintained by the City of Ann Arbor, and should not be routed through the tunnels without approval by the City and UPE-Tunnels. Coordinate modifications to these services through the City of Ann Arbor, UPO-Civil department and U-M Project Coordinator.

Architectural and Structural Requirements and Considerations

Load bearing capacity:

Tunnels shall be designed for H-20 (Highway) loading. In general, wall and roof sections should be a minimum of 8” thick reinforced concrete. Some older sections of the tunnel

system do not meet this loading requirement and may need shoring where heavy loads must cross the tunnel. Confirm structural design requirements with U-M Project Coordinator.

Vaults:

Vaults are required in many areas at key junctions in the tunnel piping. Vault shall be designed to accommodate installation and maintenance of intersecting pipes, including flash tanks, condensate return units, etc. Provide a sump and simplex, high temperature sump pump at low point of each vault.

Waterproofing:

Top and sides of tunnels should include waterproofing, typically membrane type. Coordinate with U-M Project Coordinator for waterproofing requirements.

Separation between Buildings and Tunnels:

Appropriate separation is required between buildings and tunnels. At a minimum, a lockable door is required at the tunnel (using U-M standard core). Fire rated separation is not typically required. Confirm separation requirements with U-M Project Coordinator.

Hatches:

Hatches are often required to maintain reasonable access to sections of the tunnel system. Location of hatches must be carefully coordinated with U-M project coordinator and UPE-Tunnels. In general, hatches must be designed to allow installation of 20 foot long pipe sections. All sidewalk or grade level exits will be equipped with a crash bar type opening mechanism and sufficient lifting assistance mechanisms to allow a worker in a diminished physical state to fully open the hatch with one hand. Include steel ladder at each hatch. Refer to Master Specification Section 05500 – Metal Fabrication.

General Requirements and Design Considerations

Coordination with City of Ann Arbor:

Work on tunnels is often affected by City of Ann Arbor requirements associated with right of ways, street closings and paving, etc. Review proposed concepts and issues with the City of Ann Arbor in early stages of design. Coordinate all contact with the City through the UPO – Civil department, and U-M Project Coordinator.

Coordination with UPO-Civil:

Coordinate soil erosion control, tree protection, and staging through the UPO-Civil department and U-M OSEH department, in conjunction with the U-M Project Coordinator.

Confined Space:

Portions of the tunnel system are considered “confined space”, and are therefore subject to associated U-M OSEH requirements.

Field Surveys:

Design must be based on actual field surveyed conditions. U-M has extensive records on modifications made in the tunnels. However, design must be validated by field inspection prior to release of construction documents.

Mechanical Requirements and Considerations

Ventilation:

Consider need for ventilation on all tunnel projects. Confirm ventilation needs with U-M Project Coordinator and Utilities. Tunnels are ventilated primarily with outside air, through the use of supply and/or exhaust fans. Kiosks are used extensively to house ventilation intake and relief. In some areas of campus, a more aesthetically sensitive alternative may be necessary. Design ventilation system to maintain ambient plus 10F during the summer.

Water Detection:

U-M is concerned about rapid detection and response to water leaks in the tunnel system, and has installed water sensors at several system low points. Confirm water detection requirements during design. Typically, install a water sensor at low point in any new tunnel section if any point in the new tunnel section is lower than the connection point to the existing tunnel. Water sensors should be connected to the Building Automation System.

Drains:

Tunnel system does not typically include floor drains, footing drains or sumps at regular intervals. However, a sump with a simplex high temperature sump pump should be installed at vaults and building entrances.

Electrical Requirements and Considerations

Lighting:

Lighting shall be designed to maintain a minimum light level of 25 FC at the walk surface. Fixtures shall be 24 watt minimum, compact fluorescent type, with globe glass and guard. Lighting should be controlled by 20 amp manual dial timer (12-hour) located at tunnel entrances, and at intervals of 200 feet.

Electrical Receptacles:

Duplex Receptacles are typically required throughout the tunnel system. Receptacles shall be 20 amp GFCI type with waterproof covers. They shall be installed at each tunnel entrance, and at intervals of 300 feet throughout the tunnel.

Cable Trays:

All tunnels shall include an aluminum ladder-type cable tray for future use for ITCom, and other services. Tray should be approximately 12" wide x 4" deep, with 9" rung spacing and 12" minimum bending radius, unless project specific requirements are higher. Tray should be located just outside the piping supports, near the ceiling.

Conduit:

Conduit in Utility tunnels, and box trenches shall be fiberglass-reinforced epoxy, or Schedule 80 PVC, with matching fittings. Provide expansion joints every 100 feet and on both sides of every change in direction. In utility tunnels that are completely dry, consult U-M Project Coordinator as to whether rigid galvanized steel conduit may be specified instead. Building tunnels may use EMT conduit.

Fire and Smoke Detection and Alarm:

The Utility Tunnel system does not typically require a fire alarm system or notification appliances.

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GENDER INCLUSIVE TOILET/ LOCKER ROOM

Scope

Each new building or major renovation project requires the inclusion of at least one single occupancy Gender Inclusive toilet room as part of the project. The University of Michigan Requirement, and exceptions will be granted by UM Design Manager only under unusual, well-documented circumstances provided in writing by the unit or division funding the project.

Related Sections

U-M Design Guideline Sections:

[Codes and Regulatory Agencies](#)

[10 28 00 Toilet Accessories](#)

[Preferred Manufacturers List](#)

Design and Installation Requirements

Provide the following:

- A door with a privacy lock (lockable from the inside and openable in an emergency from the outside.)
- Room shall be barrier free per current codes.
- Room shall include toilet and lavatory as a minimum. In specific applications, as needed a shower and changing area shall also be included. Provide applicable toilet accessories. At the discretion of user, based on occupancy additional accessories can be included, ie. baby changing station, lockers.
- Where possible, locate toilet room so that it is convenient for the majority of building occupants. This includes an unobstructed barrier free path of access to room.

FIRE COMMAND CENTER

General

When designing a new high-rise building or when upgrading an existing building to a high-rise, provide a Fire Command Center for emergency operations.

Related Sections

Design Guideline Technical Sections:

[10400 - Signage](#)

[14000 – Elevators](#)

[15300 – Fire Protection](#)

[16300 – Electrical Power Systems](#)

[16720 – Fire Alarm System](#)

U-M Master Specifications:

[14210 – Electric Traction Elevators](#)

[14240 – Hydraulic Passenger Elevators](#)

[15320 – Fire Pumps](#)

[16231 – Engine-Generator System](#)

[16720 – Fire Alarm System](#)

References

MBC, “Michigan Building Code”

MMC, “Michigan Mechanical Code”

NFPA 72, “National Fire Alarm Code”

Fire Command Center Room Requirements

Locate the Fire Command Center on the ground floor and near the building entrance designated for initial Department of Public Safety (DPS) and Ann Arbor Fire Department response. Provide access to the room from the interior of the building. If possible, also provide access directly from the exterior of the building.

The room shall be a minimum of 96 square feet with a minimum dimension of 8 feet. Separate the room and its access route from the remainder of the building by not less than a 1 hour fire resistance-rated fire barrier. Ventilate the room in accordance with the MBC and MMC.

Obtain DPS approval before expanding the room to incorporate other building functions such as a reception desk, security office, or DPS mini-station.

Connect the room equipment, lighting, and duplex receptacles to the building’s emergency power system.

Key the door locks with a “BA” machine room series lock that is different from the other “BA” series locks in the building. Arrange for the building’s Facilities Manager to receive a copy of this unique BA series key. This will enable the DPS and Plant Operations Shops personnel with BA master keys as well as the Facilities Manager to have immediate access to the room.

Provide signage at each door with “Fire Command Center” in 1” high, bold red letters.

Fire Command Center Features

Provide a fire alarm system control panel complete with a digital annunciator, status indicating lights, audible signals, and all of the following features:

- An emergency voice/alarm communications system panel with audio generators, amplifiers, controls, indicators, and a microphone.
- A fire department two-way communications system panel with power supplies, controls, indicators, a master telephone handset, and pluggable portable handsets.
- A control and status indicator panel for air-handling systems and smoke control systems. Provide one control switch and one set of indicators for each smoke control zone as a unit, rather than one control switch and one set of indicators for each component of each zone.
- Because the fire alarm system digital annunciator indicates the status of sprinkler system flow and tamper switches, no separate sprinkler system display panel is required.
- Because the fire alarm system digital annunciator indicates the status of the fire pump, no separate fire pump status indicator is required.
- Because the fire alarm system digital annunciator stores several hundred past events, generally no printer is required.

Provide an elevator annunciator panel that indicates the location and status of each elevator.

Provide a control switch for simultaneously unlocking all non-exit discharge stairway doors that are locked from the stairway side. Do not provide a control switch for unlocking exit discharge doors that are locked by the card access control system.

Provide a telephone for Fire Department use. The telephone shall have access to the public telephone system.

Provide an emergency and standby power generator status panel for each generator. The panel shall duplicate the status indicating lights on the generator’s local control panel.

Provide a green “normal power” and a red “generator power” indicating light for each emergency and standby power automatic transfer switch (ATS) to indicate the position of the ATS. Label each pair of lights to indicate the generator and ATS equipment numbers and the types of loads connected to the ATS.

SBA - J

Provide one Plexiglas guarded, two position, “Auto-Run” selector switch to manually start the generators and enable the ATS’s to transfer. The selector switch shall have the following features:

- One Form-C maintained contact for each ATS (except do not provide a contact for a fire pump ATS that is integral to the fire pump controller). Provide control wiring from each switch contact to its ATS.
- In the “Auto” position, each switch contact shall place its associated ATS in normal stand-by mode.
- In the “Run” position, each switch contact shall simulate a loss of normal power to its ATS. This shall cause each ATS to start its generator and then transfer to generator power when its generator reaches proper voltage and frequency (except the ATS’s may wait to transfer until normal power is lost if the building has multiple generators and “paralleling switchgear”).
- A nameplate identifying the purpose of the selector switch.

Provide schematic building plans indicating the typical floor plan and detailing the building core, means of egress, fire protection systems, fire-fighting equipment, and fire department access. Provide storage for these building plans.

Provide a work table.

Provide a public address system, but only if one is required. Generally a public address system is not required.

SBA-K-H: HEALTHCARE PROCEDURE ROOM INFECTION CONTROL TYPES AND REQUIREMENTS

General

This Special Building Area (SBA) guideline applies to new procedure rooms within University of Michigan Hospitals and Health Centers (UMHHC) inpatient and outpatient facilities, owned or leased. This SBA applies to clinical areas where invasive to minimally invasive procedures are performed.

The definition for, and the use and understanding of, the various procedure rooms names used within a healthcare setting (i.e. "Operating Room", "Procedure Room", "Treatment Room", etc) varies greatly amongst healthcare codes, industry standards, design professionals, and UMH healthcare staff. Therefore the room types noted below and throughout the document were developed by UMHHC to better clarify the needs and requirements of the various procedure rooms.

This SBA was therefore created to establish a universal understanding amongst our design professionals, construction coordinators and staff, clinicians, infection control, and maintenance on how these spaces should be designed and operated. The information expressed in this SBA is meant to standardize the design and performance of procedure room types and requirements across the UMHHC campuses and is based on close coordination with the State of Michigan Department of Community Health and the UMHHC Infection Control and Epidemiology Department (ICE), along with industry-wide best practices. Where the information in this SBA seems to exceed that of regulating healthcare codes, the AE shall nevertheless utilize the information expressed here in this SBA. Where the information in this SBA would serve to conflict or be in direct violation of regulating healthcare codes, the A/E shall bring this to the attention of the University Project Manager. At no time shall governing healthcare codes be violated.

The use and application of these procedure room types is governed by UMHHC Infection Control and Epidemiology (ICE) in conjunction with the MI Health Facilities Engineering Section (HFES). All determinations on room types, and the procedures performed within, shall be made by UMHHC ICE and MI HFES. UMHHC Infection Control and Epidemiology shall be the authority on room type classifications for specific procedures.

UMHHC Definitions:

Semi-Restricted Corridor/Rooms: The corridor area within the "Red Line" where proper attire is required, including scrubs or protective coveralls ("Bunny Suit") and hair coverings.

Restricted Corridors/Rooms: The sterile core or other restricted areas where proper attire is required, with the possible addition of a surgical face mask as directed by Infection Control.

Operating Room: A room licensed by the state as an Operating Room. (Infection Control "IC" Room Type 1 room as noted below)

Treatment, Procedure Rooms: General clinical room names used to describe clinical rooms where various surgical and non-surgical "procedures" are performed, varying in invasiveness from an Operating Room to an Exam Room. The goal of this document is to clarify these room names by the use of the IC Room Types 1 through 7.

Clear Area (Clear Square Footage): All room areas are to be calculated based on the actual clear floor area, excluding any built in cabinetry, boxed out low wall air returns, columns and the like.

Equipment List: A list of all equipment for a room or space, provided by UMHHC Facilities Planning and Development (FPD) Capital Equipment Planner.

Equipment Plan: A scaled 2-D or 3-D architectural plan which shows all "equipment", furniture, built-ins and other items graphically within a room or space. These may include floor plans, reflected ceiling

plans, and interior elevations, and are prepared by the A/E. "Equipment" here includes all items located in the room, as noted on the Capital Equipment "Equipment List", Contractor installed equipment and infrastructure items, items provided by Interior Design, Medical Center Information Technology (MCIT) supplied equipment, and/or re-use items.

Equipment Plan and Room Size:

The size of each room type listed below is the minimum per code. In many cases, however the Equipment Plan will dictate that the room needs to be larger than the code minimum based on the equipment to be used within the room and staff movement paths.

For example, a room required to be 400 clear square feet might have overall dimensions within the interior walls of 24' x 24' (576 SF) within the walls if 2' of built-ins, air returns and equipment around the perimeter are required. Additional equipment and staff movement paths may dictate the room be even larger.

Prior to finalizing room size, the A/E shall create Equipment Plans, including all fixed and movable equipment and furnishings to be used in the room for the specific cases expected in the room. If multiple procedures or equipment layouts are expected, each case should be laid out individually. Any equipment to be stored in the room when not in use for a particular case shall be accounted for. The Equipment Plan must include patient and staff locations, and include adequate circulation space (min. 30") for staff to circulate fully around the perimeter of the room, and through the doors to the room, during the case. A Reflected Ceiling Plan should be created where ceiling mounted equipment are planned. Particular attention should be made to all boom and lighting layouts, and the "Sterile Field" created with the air supply. If a sterile field is to be created, it should be superimposed on the Equipment Plan. In all layouts, the location of the patient must be within the sterile field.

In addition to Equipment Plans, the cases should be mocked up with the actual equipment. The Equipment Plans shall be reviewed and approved by the Clinical department, ICE, and FPD.

Classification of Infection Control Room Types

In an effort to clarify the various types of surgical and procedure rooms and the procedures performed in each, UMH standardizes on (7) seven infection control room types for these spaces. These room types are defined in Table 1 below. UMHC Infection Control and Epidemiology Department shall maintain a separate list of procedures for each room type.

TABLE 1

Infection Control Room Type	Surgical Procedure/ Invasiveness	Common Terminology (1)
1	Invasive, major surgical procedures, above or below fascia, may involve bone or implants	Licensed Operating Room (OR)/ ASHRAE Class C Surgery/C-Section
2	Invasive, minor surgical procedure, minimally invasive- below fascia, may involve bone or implants	Procedure Room/ Minor Surgical Procedure Room/ ASHRAE Class C Surgery
3	Cardiac Catheterization, Angiography and Interventional Radiology	Procedure Room/ Angiography/ ASHRAE Class B Surgery
4	Minimally invasive- above fascia only	Treatment Room/ ASHRAE Class A Surgery
5	Endoscopic, non-invasive	General Endoscopy/ ASHRAE D&T
6	Bronchoscopy	Bronchoscopy/ ASHRAE D&T
7	Needle guided procedure	Exam Room/ ASHRAE D&T
8	Minimally invasive- above fascia only	Exam Room/ASHRAE D&T

(1) Terminology per HFES Minimum Design Standards for Healthcare Facilities in Michigan, AIA Guidelines and/or ASHRAE Standards.

The A/E shall clearly indicate the Room Name & Room Type (i.e. Procedure Room- IC Type 3) on the preliminary and final construction contract documents, and in the Operational Narrative.

IC (Infection Control) Room Types

The A/E shall ensure that all rooms identified under this SBA shall conform to the criteria stated under Table 2 "Architectural", Table 3 "Electrical" and Table 4 "Mechanical" at the end of this document.

IC Room Type 1 and IC Room Type 2:

Architectural

Due to the need to maintain space pressurization control, the A/E shall give special attention to providing a sealed space envelope; including extending all walls to the structure above and sealing all floor, wall and ceiling penetrations (i.e. light switch back boxes, conduit and pipe penetrations, etc) as well as the intersection of the wall and underside of the structure above.

In an effort to maintain a sealed, pressurized room envelope, the A/E shall limit the infrastructure (i.e. ductwork, piping, conduit, etc) passing over an IC Type 1 or 2 room to only that which serves the space. All items requiring regular maintenance (i.e. terminal air boxes, etc.) or accessibility (i.e. valves, etc.) shall be located outside of the room envelope so as to preclude the need to access such devices from within the space.

The stretcher access doors shall be automated with touch-less hand actuated sensors. The width will be determined by clinical needs and site conditions; a typical room might have a pair of doors totaling 6 feet wide. A wall mounted shut-off switch for these doors will be located on the room side to prevent accidental usage during a procedure. Where possible, a bi-directional "man-door" should be used for staff traffic. Push paddle hands-free type hardware should be used so that it is possible to enter the room without using hands or arms. All doors shall have closers. The door material should be carefully considered for durability, for example fiberglass rather than painted hollow metal, and door frame protection should also be installed.

Provide properly sized and placed access hatches to allow for maintenance and related activities associated with any equipment placed, or may be placed, above the ceiling. Properly sized meaning they are big enough for a normally sized person, to access and maintain the equipment easily and safely. Where shoulder clearance is required, access hatches shall be a minimum of 24" x 24".

The Architect shall provide carefully and completely laid out reflected ceiling plan showing all diffusers, lights, surgical column supports, fire suppression sprinklers, smoke detectors, access hatches, A/V equipment, and any other equipment to insure coordination and utility of the design. Also, provide cross-section of above ceiling space, sufficiently detailed to insure proper space and accessibility for all installed systems is available above the ceiling. The ceilings will consist of a gasketed accessible ceiling system. The ceiling tiles shall have a washable surface and must stay in place during the washing process. Tile clips will only be allowed where tiles are less than 2 square feet in size or as directed otherwise by the Design Manager.

All room finishes will be selected by UMHHC FPD, Interior Design, in consultation with IC and other UMHHC staff. Monolithic, non-porous wall surfaces, such as PVC or FRP are preferred. Flooring material and base material shall be monolithic, such as terrazzo or an epoxy flooring product, or a resilient sheet flooring.

Colors of ceilings, walls and floors shall be selected with consideration of their effects on the lighting levels in the room in all room types. Reflectance levels of less than 80% for ceilings, 50% for walls and 20% for floors shall be allowed for in the lighting design.

Flooring patterns may be desired to indicate the sterile field. If provided, construction documents must indicate that floor patterns match the extent exactly. Floor patterns may be desired to indicate other operational or equipment limits, such as gauss lines.

Mechanical

Rooms shall be served by a dedicated HVAC control zone to actively maintain the room's thermal comfort and pressurization (typically either a dedicated AHU or supply and return terminal airflow control boxes in

conjunction with a reheat coil). System shall be controlled to maintain room temperature and balanced to maintain room pressurization, as measured via a differential pressure monitor across the main doorway from the clean corridor. Dynamic pressure control is neither required nor desired. Return airflow shall be controlled to maintain the active measured supply airflow minus a fixed airflow offset setpoint (initially assume an offset of 300-500 CFM, depending on number & size of doorways into space). Airflow offset shall be determined by test & balance contractor, as required to maintain a room pressurization of 0.04"-0.06"wc.

Space temperature and humidity sensors shall be mounted in the common return air main from the room. A door contact switch shall be provided at the main automated door into the space. Provide a wall mounted human interface panel within the room that displays room temperature, temperature set-point, humidity, occupied/ unoccupied mode, space pressurization and airchange rate. Panel shall allow the users to adjust temperature within the room. Panel shall provide local indication if room humidity, air change rate, or pressurization are outside of acceptable limits. Protect wall-mounted panel with a stainless steel "crash-guard" where applicable.

A/E shall clearly state the room pressurization requirement (i.e. goal is 0.04"-0.06"wc) on the design drawings and indicate a means of achieving pressurization (i.e. throttle return/ exhaust airflow).

Rooms shall include controls to automatically reduce ventilation during unoccupied periods for energy conservation. This control system shall include at least two ceiling or wall mounted dual technology (passive infrared plus microphonic sensing) occupancy sensors per room, selected for full room sensing coverage, to automatically determine room occupancy. All room sensors must simultaneously detect unoccupied conditions for a period of not less than 30 minutes in order to enable unoccupied mode operation. The system must be designed such that a failure at any level (i.e. loss of power to sensor, cut or disconnected communication wire, etc.) will cause the system to assume occupancy and operate in an occupied mode. During unoccupied mode operation, airflow shall be controlled down to the minimum level necessary to maintain required room pressurization, and to maintain the room temperature setpoint.

In addition to standard system alarms, UMHHC's Building Management System (BMS) shall monitor room humidity, airflow/air change rate, and room differential pressure, and shall provide local indication to surgical staff via a local human interface panel or surgical front desk monitor. This system shall provide the following warnings and alarms to surgical staff:

Criteria	Warning Alarm (Yellow)	Alarm (Red)
Room Humidity	≥58%RH or ≤22%RH	≥60%RH or ≤20%RH
Airchange Rate	≤17 ACH	≤15 ACH
Room Pressurization (1)	0.020" wc for >5 min	0.010" wc for > 5 min

(1) Room pressurization alarms shall be disabled when door contact is open. Installations without door switches shall wait for 30 minutes of continuous status below alarm threshold prior to activating the alarm.

Additional front-end alarms may be required, contact UMH project engineer for standard sequence of operation for OR HVAC systems.

UMHHC preference is to provide humidity control in each room via a central AHU humidifier (set to maintain a discharge air humidity level) in conjunction with a dedicated duct-mounted "booster" humidifier for each room to fine-tune humidity levels to meet individual room set points. Where dedicated room humidifiers are not provided, the maximum number of rooms on a common humidifier shall be limited to four (4) rooms. The A/E shall verify requirements with HFES and UMHHC Mechanical Engineer.

Where ceiling booms are used for medical gas service, in addition to those gases provided on the boom, provide the following properly labeled medical gas outlets on the wall at the head end of the table: (2) MVAC with slides, (1) OX, (1) WAGD, and (1) MA.

All type 1 & 2 rooms shall be protected by a dedicated zone, double-interlock pre-action fire suppression system provided with a pull station located outside of the room(s) served.

Electrical

These rooms shall be served by critical power derived from two separate transfer switches, distributed on separate power risers and served from separate panels. Since these rooms are to be considered 'wet locations', isolated power supplies (IPS), with line isolation monitors, shall be installed in each room – two per room. The isolated power supplies shall be connected to the two critical power sources noted above.

A minimum of 48-outlets (24-duplexes) shall be installed in each room, with 50% fed from one IPS and the balance from the other IPS. Please note that 48 is the minimum, provide more when the program dictates the need for more. [This number of outlets is in addition to any normal power supplied outlets that may be required by code.] The outlets shall be conveniently, and evenly, spaced around the room-including those installed in the surgical booms. All outlets shall be hospital grade.

Outlets shall be served by 20-ampere circuits, using XHHW-2 wire. Normally no more than 4-outlets (2-duplexes) shall be connected to each circuit – unless the circuit is being dedicated to a single purpose. [A good policy is to limit power to 1000-watts per circuit.]

Lighting shall be 5000-K fluorescent, with a maintained room lighting level of minimum 150-footcandles within 6-feet of operating table/theatre. The balance of the room shall have minimum 75-footcandles. Provide switching and controls to permit reduced lighting during portions of the procedures that may mandate this, as noted in the program. All of the lighting will be on critical power, served from two circuits that are fed from different transfer switches. Approximately 33% of the lighting fixtures shall be battery back-up to one of the ballasts in the fixture, to provide illumination during the period before emergency power is restored. [All of the above are in addition to the lighting provided by the surgical lights themselves.]

Provide power receptacles, and data outlets, for at least three large, wall-mounted, video display units (large computer screens) at locations defined by OR staff. Carefully coordinate the mounting elevation, and locations, of these with the staff.

Provide a raceway, junction and pull box system, power and data outlets, for installation of A/V equipment that may be provided either in the base project, or at a future date. A detail drawing will be made available to assist in this.

At least 50% of the power outlets, and lighting, in scrub area, shared imaging rooms, and/or adjacent equipment rooms shall be on critical power, but not necessarily on IPS power. The outlets not on IPS shall have GFCI. Coordinate exact needs for power and data with equipment planners and OR staff. In addition, imaging systems, critical for completion of the surgeries, shall be served by critical power.

When program notes need for laser power outlets, these outlets may be supplied by a shared IPS serving several rooms. Carefully coordinate with Capital Equipment Planner, Bio-Medical Engineering and OR staff in the placement and sizing of these outlets.

Provide open channel communications system (in essence hands free) to allow communication for persons anywhere in the room to other defined remote locations. Said locations needing this system will be defined during DD.

No fire alarm strobes or speakers shall be installed in these rooms. Nor shall they be in adjacent corridors, if intervening walls have extensive glass. These instead will be placed in control rooms, or scrub areas not in line of sight of staff working on the patient.

IC Room Type 3:

Architectural

Due to the need to maintain space pressurization control, the A/E shall give special attention to providing a sealed space envelope; including extending all walls to the structure above and sealing all floor, wall & ceiling penetrations (i.e. light switch back boxes, conduit & pipe penetrations, etc) as well as the intersection of the wall and underside of the structure above.

In an effort to maintain a sealed, pressurized room envelope, the A/E shall limit the infrastructure (i.e. ductwork, piping, conduit, etc) passing over a Type 3 room to only that which serves the space. All items

requiring regular maintenance (i.e. terminal air boxes, etc.) or accessibility (i.e. valves, etc.) shall be located outside of the room envelope so as to preclude the need to access such devices from within the space. The stretcher access doors shall be automated with touch-less hand actuated sensors. A wall mounted shut-off switch for these doors will be located on the room side to prevent accidental usage during a procedure. Where possible a bi-directional "man-door" should be used for normal procedure traffic. Push paddle hands-free type hardware should be used. All doors shall have closers.

Provide properly sized and placed access hatches to allow for maintenance and related activities associated with any equipment placed, or may be placed, above the ceiling. Properly sized meaning they are big enough for a normally sized person, to access and maintain the equipment easily, and safety. The number of hatches shall be based upon equipment installed above ceiling; however, at least two shall be installed regardless. Where shoulder clearance is required, access hatches shall be a minimum of 24" x 24".

Architect shall provide carefully and completely laid out ceiling plan showing all diffusers, lights, surgical column supports, fire suppression sprinklers, smoke detectors, access hatches, AV equipment, and any other equipment to insure coordination and utility of the design. Also, provide cross-section of above ceiling space, sufficiently detailed to insure proper space and accessibility for all installed systems is available above the ceiling. The ceilings will consist of a gasketed accessible ceiling system. The ceiling tiles shall have a washable surface and must stay in place during the washing process. Tile clips will only be allowed where tiles are less than 2 square feet in size or as directed otherwise by the Design Manager.

All room finishes will be selected by UMHHC FPD, Interior Design, in consultation with IC and other UMHHC staff. Flooring patterns may be desired to indicate operational limits. If provided, construction documents must indicate that the floor patterns match the limits exactly.

Mechanical

Rooms shall be served by a dedicated HVAC control zone to actively maintain the room's thermal comfort and pressurization (typically either a dedicated AHU or supply and return terminal airflow control boxes in conjunction with a reheat coil). System shall be controlled to maintain room temperature and balanced to maintain room pressurization, as measured via a differential pressure monitor across the main doorway from the clean corridor. Dynamic pressure control is neither required nor desired. Return airflow shall be controlled to maintain the active measured supply airflow minus a fixed airflow offset setpoint (initially assume an offset of 300-500 CFM, depending on number & size of doorways into space). Airflow offset shall be determined by test & balance contractor, as required to maintain a room pressurization of 0.04"-0.06"wc.

Space temperature and humidity sensors shall be mounted in the common return air main from the room. A door contact switch shall be provided at the main automated door into the space. Provide a wall mounted human interface panel within the room that displays room temperature, temperature set-point, humidity, occupied/ unoccupied mode, space pressurization and airchange rate. Panel shall allow the users to adjust temperature within the room. Panel shall provide local indication if room humidity, air change rate, or pressurization are outside of acceptable limits. Protect wall-mounted panel with a stainless steel "crash-guard" where applicable.

A/E shall clearly state the room pressurization requirement (i.e. goal is 0.04"-0.06"wc) on the design drawings and indicate a means of achieving pressurization (i.e. throttle return/ exhaust airflow).

Rooms shall include controls to automatically reduce ventilation during unoccupied periods for energy conservation. This control system shall include at least two ceiling or wall mounted dual technology (passive infrared plus microphonic sensing) occupancy sensors per room, selected for full room sensing coverage, to automatically determine room occupancy. All room sensors must simultaneously detect unoccupied conditions for a period of not less than 30 minutes in order to enable unoccupied mode operation. The system must be designed such that a failure at any level (i.e. loss of power to sensor, cut or disconnected communication wire, etc.) will cause the system to assume occupancy and operate in an occupied mode. During unoccupied mode operation, airflow shall be controlled down to the minimum level necessary to maintain required room pressurization, and to maintain the room temperature setpoint.

In addition to standard system alarms, UMHHC's Building Management System (BMS) shall monitor room humidity, airflow/air change rate, and room differential pressure, and shall provide local indication to surgical staff via a local human interface panel or surgical front desk monitor. This system shall provide the following warnings and alarms to surgical staff:

Criteria	Warning Alarm (Yellow)	Alarm (Red)
Room Humidity	≥58%RH or ≤22%RH	≥60%RH or ≤20%RH
Airchange Rate	≤17 ACH	≤15 ACH
Room Pressurization (1)	0.020" wc for >5 min	0.010" wc for > 5 min

(1) Room pressurization alarms shall be disabled when door contact is open. Installations without door switches shall wait for 30 minutes of continuous status below alarm threshold prior to activating the alarm.

Additional front-end alarms may be required, contact UMH project engineer for standard sequence of operation for OR HVAC systems.

Where ceiling booms are used for medical gas service, in addition to those gases provided on the boom, provide the following medical gas outlets on the wall at the head end of the table: (2) MVAC with slides, (1) OX, (1) WAGD, and (1) MA.

All type 3 rooms shall be protected by a dedicated zone, double-interlock pre-action fire suppression system provided with a pull station located outside of the room(s) served.

Electrical

These rooms shall be served by critical power derived from two separate transfer switches, distributed on separate power risers and served from separate panels, two per room. Since these rooms are to be considered 'wet locations', isolated power supplies (IPS), with line isolation monitor, shall be installed in each. The isolated power supplies shall be connected to the one of the critical power sources noted above.

A minimum of 36-outlets (18-duplexes) shall be installed in each room, with 50% fed from one IPS and the balance from the second IPS. Please note that 36 is the minimum, provide more when the program dictates the need for more. [This number of outlets is in addition to any normal power supplied outlets that may be required by code.] The outlets shall be conveniently, and evenly, spaced around the room-including those that may be installed in the surgical booms. All outlets shall be hospital grade.

Outlets shall be served by 20-ampere circuits. Use XHHW-2 wire for all wiring in these rooms. Normally no more than 4-outlets (2-duplexes) shall be connected to each circuit – unless the circuit is being dedicated to a single purpose. [A good policy is to limit power to 1000-watts per circuit.]

Lighting shall be 5000-K fluorescent, with a maintained room lighting level of 75-footcandles within 6-feet of operating table/theatre. (IR shall have 150 fc) The balance of the room shall have min 25-footcandles. Provide switching and controls to permit reduced lighting during portions of the procedures that may mandate this, as noted in the program. All of the lighting will be on critical power, served from two circuits that are fed from different transfer switches. Approximately 33% of the lighting fixtures shall be battery back-up to one of the ballasts in the fixture, to provide illumination during the period before emergency power is restored. [All of the above are in addition to the lighting provide by the surgical lights themselves.]

Provide power receptacles, and data outlets, for at least two large, wall-mounted, video display units (large computer screens) at locations defined by OR staff. Carefully coordinate the mounting elevation, and locations, of these with the staff.

Unless noted otherwise in the program statement, provide a raceway, junction and pull box system, power and data outlets, for installation of A/V equipment that may be provided either in the base project, or at a future date. A detail drawing will be made available to assist in this.

At least 50% of the power outlets, and lighting, in scrub area, shared imaging rooms, and/or adjacent equipment rooms shall be on critical power, but not necessarily on IPS power. The outlets not on IPS

shall have GFCI. Coordinate exact needs for power and data with equipment planners and OR staff. In addition, imaging systems, critical for completion of the surgeries, shall be served by critical power.

When program notes need for laser power outlets, these outlets may be supplied by a shared IPS serving several rooms. Carefully coordinate with Capital Equipment Planner, Bio-Medical Engineering and staff in the placement and sizing of these outlets.

Provide open channel communications system (in essence hands free) to allow communication for persons anywhere in the room to other defined remote locations. Said locations needing this system will be defined during DD.

No fire alarm strobes or speakers shall be installed in these rooms. Nor shall they be in adjacent corridors, if intervening walls have extensive glass. These instead will be placed in control rooms, or scrub areas not in line of sight of staff working on the patient

IC Room Type 4:

See Tables 2, 3, 4. All doors shall have closers.

IC Room Type 5 and 6:

See Tables 2, 3, 4

IC Room Type 7:

See Tables 2, 3, 4.

IC Room Type 8:

Architectural

Refer to typical Infection Control Room Type layout drawings on [Standard Details](#) page. Doors should be 3'-2" minimum. Privacy should be provided at doorway by way of curtains and/or hinge gasketing. Walls should be full height to structure above, and acoustically insulated. If plenum returns are used, walls should extend as far as practical above ceiling plane and return-air acoustical boots should be installed. Wall finishes should be durable and cleanable. Wall protection should be installed. Sink should be located as close to the doorway as practical. Flooring should be seamless, with an applied cove base typically.

TABLE 2: ARCHITECTURAL

Infection Control Room Type	Access Restrictions	Minimum Room Size (Clear Square Footage) Actual size determined by Equipment Plan	Min. Room Ceiling Height (ft)	Floors Monolithic	Base	Walls
1	Access from semi-restricted hall in a semi-restricted suite, room is restricted during procedure	400 sq. ft. min. clear/ 600 for ortho, cardiac. Equipment may dictate significantly larger	10'-0"	Yes	Integral	FRP/PVC
2	Access from semi-restricted hall, room is semi-restricted or restricted during procedure Not to be a shared semi-restricted hall that also serves Room Type 1 above.	250 sq. ft. code minimum; Equipment may dictate significantly larger	10'-0"	Yes	Integral	FRP/PVC
3	Access may or may not be from a restricted hall, room is unrestricted when sterile field not present	400 sq. ft. code minimum. (Note 1) Equipment may dictate significantly larger	10'-0"	Yes	Integral	FRP/PVC
4	Access may or may not be from a restricted hall, room is unrestricted when sterile field not present	250 sq. ft. code min. Equipment may dictate significantly larger	9'-0"	Yes	Applied	Washable
5	Unrestricted access and room	250 sq. ft. code min. Equipment may dictate significantly larger	9'-0"	Yes	Integral	Washable
6	Unrestricted access and room	250 sq. ft. code min. Equipment may dictate significantly larger	8'-0"	Yes	Integral	Washable
7	Unrestricted access and room	Highly dependent upon equipment	Highly dependent upon equipment	Yes	Applied	Washable
8	Unrestricted access and room	120 sq. ft. (inpatient) 100 sq. ft. (outpatient) Code min.	8'-0"	Yes	Applied	Washable

References:

- Minimum Design Standards for Healthcare in Michigan, 2007
- ASHRAE/ASHE Standard 170- Ventilation of Health Care Facilities, 2008
- UMH Infection Control Policy, Surgical Site Infection Prevention, 2008
- Guidelines for Design and Construction of Health Care Facilities, 2010

Note:

1. IR Single plane, 600 SF; BiPlane 650 SF; CT/Biplane (Hybrid) 700 SF
IR Equipment room Single plane 60 SF, BiPlane 80SF, CT/Biplane (Hybrid) 200 SF
IR Control Room: Single plane 180 SF, BiPlane 200 SF, CT/BiPlane (Hybrid) 250 SF

TABLE 3: ELECTRICAL

Infection Control Room Type	Wet Location	Number of Power Sources (Note 1)	Isolated Power (IP) Required	Number of IP (Note 5)	Minimum Number of Outlets (Note 2)	Multi-level Room Lights (Note 12)	Battery Lights	Green (Color) Lights (Note 6)	Fire Alarm 'Horns' and Strobes	Hands Free 'Intercom' (Note 8)	Audio/Visual 'Ready' (Note 9)	Flat screen monitor (White Board) Ready (Note 10)	Radiology Display Ready (Note 10)	Booms (Note 9, 11)
1	Yes	2 (Note 3)	Yes	2	48	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
2	Yes	2 (Note 3)	Yes	2	48	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
3	Yes	2 (Note 3 and 13)	Yes	2	36	Yes	Yes	(Note 7)	No	Yes	Yes	Yes	Yes	No
4	(Note 4)	1 (Note 14)	(Note 4)	(Note 4)	24	Yes	Yes	No	No	No	No	No	No	No
5	No	1 (Note 15)	No	0	24	Yes	No	No	Yes	No	No	No	No	No
6	No	1 (Note 15)	No	0	24	Yes	Yes	No	Yes	No	No	No	No	No
7	No	1 (Note 15)	No	0	16	Yes	No	No	Yes	No	No	No	No	No
8	No	1 (Note 16)	No	0	16	Yes	Yes	No	Yes	No	No	No	No	No

General Notes:

- In room types 1, 2, 3 and 4 provide sufficient battery backed lighting to maintain a minimum of 30-fc, in at least the sterile field area of the room, for the 10-seconds required to bring on line the generator power.
- In rooms needing green lighting, provide multi-lamp fixtures with individual switching controls for at least the sterile field area of the room. Critical Power shall be provided as noted in the following example. The green color shall be achieved through the use of standard 5000-K lamps, but with green color sleeves over the lamps. [One such design scenario might include the use of six-lamp fluorescent fixture system, in the area of the sterile field. In such a design the middle two (5000-K) lamps would be tied to a Critical Power circuit and would have battery back-up, the two lamps nearest the sterile feed (5000-K) would be tied to a second Critical Power (but with no battery back-up), and the final two would be the green color lights, also tied to Critical Power.]
- Nurse station area in the room, shall have dimmable task light - LED or equivalent.
- Newer Type 1, 2, and 3 rooms have been equipped with lighting control system to control all lighting in the room. Base systems have typically had 6-buttons – up to 5 'scenes' plus off. Control stations at entrance to room from sterile corridor, and another at the nurse's station in the room. Provide manual over-rides to accommodate failure of lighting controller when appropriate.
- Low, recessed, wall mounted lighting (LED or equivalent) shall be provided for the safety of the staff in the room, when main lighting is off as may be required for any given procedure.
- All receptacles served from Critical Power shall be red, with red cover plates. Those fed from normal power shall be ivory, or brown, to match the building standard.
- When Normal Power is the second source to a room, the number of equally spaced receptacles shall be similar to the number of Critical Power receptacles. In rooms with only one power source being needed, and that source is from the Critical Power branch, also provide at least one normal power receptacle on each wall.
- In room types 4, 5, 6, and 7, located in buildings without generators, provide battery-backed power in the overhead lighting fixtures (or by separately mounted

wall 'bug-eye' fixtures) to provide a minimum of 15-foot-candles of lighting for 20-minutes or more.

Notes:

1. When two sources of power are required as noted above, and there is Critical Power from independent transfer switches, use these two Critical Power sources. In other cases use one Critical power source, and one normal source.
2. The noted number of outlets indicated is minimum number required by codes to meet clinical needs, supply additional outlets as clinical needs and/or good practice requires. (Note that the number indicated here is for the number of 'outlets', the number of duplexes is half of these numbers).
3. The outlets from the two sources shall be equally spaced around the room, except as modified by Note 5.
4. Normally not a wet location. Ask chief clinician if any of the Type 4 rooms will have procedures that should be considered 'wet'. If wet location designation applies to any (or all) such rooms, provide one isolated power (IP) system in those room(s). Rooms, not defined as 'wet location', and not having isolated power, should have a sign at the entrance noting "Room is not equipped with isolated power supplies".
5. When only one isolated power (IP) system is noted or required, confer with clinician on placement of IP outlets within room (evenly spaced or not).
6. Noted rooms shall normally be designed for green (color) lighting as a supplement to the white lighting. This green lighting is used in cases where normal white lighting is inappropriate. Affirm need with chief clinician assigned to project team.
7. Confer with chief clinician assigned to project team regarding the procedures to be done in some, or all, of the Type 3 rooms in project scope.
8. At minimum, intercom shall be among noted rooms and main nurse station (or control station) in suite. Ask if additional locations need to be included in the hands free intercom system.
9. Provide microphone, camera and speaker boxes in ceiling with raceways to an A/V 'hub' location in the room. Also, provide one 2" conduit from each boom to the hub, and two 2" conduits from the hub to a 12"x12" recessed box at nurse's desk. Provide power from isolated power system to the hub location, and to the nurse's desk. Affirm details on quantities of boxes and raceway sizes with assigned Electrical Engineer and Capital Equipment Planner.
10. Normally provide a duplex outlet, and data outlet, on wall at locations defined by chief clinician and/or their designee.
11. Provide power, data, A/V, gases, and other services to booms, confer with Capital Equipment planner.
12. Verify if dimming of lights is also required for certain procedures.
13. Imaging machines and associate controls shall be served by UPS power or sufficient space shall be allotted in the machine room for a future stand-alone UPS unit.
14. Critical power source required with one receptacle in room served by normal power.
15. Normal power source is acceptable with one receptacle in room served by critical power.
16. Normal power source is acceptable.

TABLE 4: MECHANICAL

Infection Control Room Type	Room Air Pressure	Pressure Monitor	Pressure Control (0.03"-0.10"w.c.)	Min. Air Changes/ Hr. (Outside air)	Min. Air Changes/ Hr. (Total)	Humidity (%RH)	Temperature range (User adjustable) (Note 1)	Final Filtration (MERV)	Air Supply Centered above surgical site	Non-Aspirating Supply	Ducted Air Return	Return Near Floor (Minimum two opposite locations)	Re-circulated Air Units	Hand Wash Sink in Room	Scrub Sinks Outside of Room	Washable Devices (i.e. thermostats, etc)
1	Out/ Positive	Yes	Yes	4	20	30-60	62-73	14	Yes	Yes	Yes	Yes	No	No	Yes	Yes
2	Out/ Positive	Yes	Yes	4	20	30-60	68-73	14	Yes	Yes	Yes	Yes	No	No	Yes	Yes
3	Out/ Positive	Yes	Yes	4	20	30-60	68-73	14	Yes	Yes	Yes	Yes	No	No	Yes	Yes
4	Out/ Positive	N/A	N/A	3	15	30-60	70-75	14	Yes	Yes	Yes	N/A	No	Yes	No	No
5	Out/ Positive	N/A	N/A	2	15	30-60	68-73	14	N/A	N/A	Yes	N/A	No	Yes	No	No
6	In/ Negative	Yes	Yes	2	12	30-60	68-73	14	N/A	N/A	Exh	N/A	No	Yes	No	No
7	Neutral/ Positive	NA	NA	2	6	Max 60 (Note 2)	70-75	NA	NA	N/A	Yes	NA	N/A	Yes	No	No
8	N/A	N/A	N/A	2	6	Max 60	70-75	N/A	N/A	N/A	Yes	N/A	N/A	Yes	No	No

References:

- Minimum Design Standards for Healthcare in Michigan, 2007
- ASHRAE/ASHE Standard 170- Ventilation of Health Care Facilities, 2008
- UMH Infection Control Policy, Surgical Site Infection Prevention, 2008

Notes:

1. Consideration must be given to user requests for elevated temperatures and / or rapid increase of room temperature based on the protocol of the procedures

being performed, for example the need to maintain a 90 degree room temperature. Where non-aspirating supply is required, controls must be in place to maintain the air flow pattern (i.e. "sterile field") while the temperature is increased.

2. Confirm minimum and maximum humidity levels with imaging or other equipment.

SBA-L-H: PATIENT CARE AND SUPPORT SPACES ROOM TYPE REQUIREMENTS

GENERAL

This Special Building Area (SBA) guideline applies to new and renovated patient care and support space types within the University of Michigan Hospitals and Health Centers (UMHHC) that are not covered by SBA-K-H – “Healthcare Procedure Room Infection Control Types and Requirements”. That document addresses room types such as Operating and Procedure rooms. This document addresses all of the subsequently listed room types in UMHHC either owned or leased.

The information included in this SBA is meant to standardize the design and performance of a variety of typical spaces across the UMHHC campuses and is based on close coordination with the State of Michigan Department of Community Health and UMHHC Infection Control Department, along with industry-wide best practices. Where the information in this SBA exceeds that of regulating healthcare codes, the A/E shall utilize the information expressed in this SBA. Where the information in this SBA would serve to conflict or be in direct violation of the governing regulating healthcare codes, the A/E shall bring this to the attention of the University Project Manager. Under no circumstances shall the governing healthcare or any other code be violated.

In general, use the latest edition of the Facilities Guidelines Institute’s “Guidelines for the Design and Construction of Health Care Facilities” as a design guideline. Review any discrepancies with the Design Manager.

TABLE OF CONTENTS	PAGE
GENERAL	1
PROTECTIVE ENVIRONMENT (PE) & AIRBORNE INFECTION ISOLATION (AI) ROOMS	1
PREPARATION/RECOVERY BAY/ROOM.....	2
NURSING STATION	3
MEDICATION ROOM	3
NOURISHMENT ROOM	4
SOILED UTILITY/SOILED HOLDING ROOM.....	4
CLEAN UTILITY/CLEAN HOLDING ROOM	4
CONFERENCE ROOM.....	5
CLASSROOM	5
CONSULTATION ROOM.....	6
ON-CALL ROOM	7
PATIENT WAITING ROOM/AREA	7
BILLING OFFICE	8
RADIOLOGY IMAGING ROOM	8
RADIOLOGY READING ROOM	9
STAFF LOUNGE/BREAK ROOM	9
PUBLIC AND/OR STAFF TOILET ROOM.....	10
BEHAVIORAL HEALTH AREAS	10

PROTECTIVE ENVIRONMENT (PE) & AIRBORNE INFECTION ISOLATION (AI) ROOMS

All PE & AI rooms shall be designed per 2003 CDC HICPAC “Guidelines for Environmental Infection Control in Health Care Facilities” to facilitate an immunocompromised patient with an airborne infectious disease.”

Architectural

All Protective Environment, Airborne Infection Isolation and Combination rooms shall have Anterooms, with self-closing doors. The Anteroom shall be sized to accommodate storage of personal protective equipment and space for staff to don PPE. Disposal of PPE shall be considered. All room exit doors shall have self-closing doors. Rooms shall have monolithic ceilings and seamless floors with an integral base. Walls and furnishings shall be easily cleanable. Viewing panels for patient observation shall be installed in doors and/or walls, with blinds or privacy curtains.

Due to the need to maintain space pressurization control, the A/E shall give special attention to providing a sealed space envelope; including extending all walls to the structure above and sealing all floor, wall & ceiling penetrations (i.e. light switch back boxes, conduit & pipe penetrations, etc) and the intersection of the wall and underside of the structure above.

In an effort to maintain a sealed, pressurized room envelope, the A/E shall limit the infrastructure (i.e. ductwork, piping, conduit, etc) passing over a PE/AI Room to only that which serves the space. All items requiring regular maintenance (i.e. terminal air boxes, etc.) or accessibility (i.e. valves, etc.) shall be located outside of the room envelope so as to preclude the need to access such devices from within the space.

Mechanical

Rooms shall be served by a supply and return/ exhaust constant volume terminal box (ie CAV), balanced to maintain a room airflow offset (typically 150-200 CFM/ door), as required to maintain a room pressurization of 0.02" wc (measured at the door between patient room and anteroom). The supply CAV shall utilize a HW reheat coil to actively maintain the adjustable setpoint of the room's thermostat.

Airborne Infection Isolation rooms utilizing ante-rooms shall be designed with negative patient rooms and positive ante-rooms, per CDC guidelines.

Room shall utilize a room differential pressure monitor mounted on the corridor wall adjacent to the door into the patient room/ anteroom. Monitors for rooms with ante-rooms shall monitor space pressurization between the patient room and ante-room as well as the ante-room and corridor. All monitors shall be integrated back to the BMS.

A/E shall clearly state the room pressurization requirement (i.e. design of 0.02" wc, minimum 0.01"wc per HFES MDS) on the design drawings and indicate a means of achieving pressurization (i.e. throttle return/ exhaust airflows).

PREPARATION/RECOVERY BAY/ROOM

These areas are used for holding patients prior to or after medical procedures and/or surgeries and are part of a larger suite that include support spaces for this particular function. ***Note: A full size mock-up of this space type is required during the design phase to validate all design elements. Reference Architectural Design Guideline 102500-H – 'Service Wall.***

Minimum Standards

- Three walls + cubicle curtain at front for visual privacy
- Minimum 10' 6" wide bay.
- Minimum 4' clear on each side of bed. Holding area shall be designed to allow for routine movement of patients and equipment without infringing on the individual cubicles or designated areas. Designs should strive to maximize self-sufficiency with a maximum visibility of patients by staff and minimum travel distances.
- Provide a minimum four normal and four critical power duplexes, as well as two data outlets for computer. Charting and patient monitoring equipment requires one critical power quad as well as two data outlets installed in close proximity to each other.
- Provide necessary medical gases
- Air supply should be located in "corridor" area with air return in bay/room.
- Lighting should be ambient/reading/exam combination fixture.
- Staff assist button on each side of bed.

- Equipment rail system for BP monitoring, glove boxes, sharps container, etc.
- Wall protection on head and side walls
- Guest and/or patient seating (at least one bariatric)

Optional Features

- Consult with user group for specific design requirements (such as bariatric beds, etc.)

NURSING STATION

These areas are used for nursing staff to attend to tasks other than direct patient care. Nursing station should include furniture/furnishings to provide for minimum storage, ergonomic seating and work surfaces for computers and/or paperwork. The station should be separated from the corridor or from other general traffic to provide a modicum of privacy for information exchange between shifts or consultation among care staff.

Minimum Standards

- Station to accommodate a minimum of two staff - more as unit requires
- Systems furniture panels for separation and acoustic control.
- Outside "walls" of panels should be hard surface, not fabric.
- Minimum of 42" high counter/transaction top + 30" high section for wheelchair accommodation.
- Work surface for writing and computing.
- Binder bins with sloped tops and locking doors.
- Light switch specific to night lighting over workstation (on critical power)
- Tackspace, whiteboard and tasklighting.
- Pencil drawer
- Box/pedestal drawer
- Ergonomic, adjustable armless task seating with casters (appropriately specified for either carpet or hard surface flooring).
- "Slatwall" components for organizing paperwork.
- Power (regular + critical hardwired)/data/phone, nurse call, intercom outlets and control 'stations' appropriate for size of station.
 - Separate raceway paths for normal power, for emergency power, and for data, including wiring management provisions.
- Finishes to coordinate with adjacent corridor (sheet vinyl/base, painted walls, etc.)
- Dedicated HVAC zone of control
- Medical gas alarm panel (on back or adjacent wall)

Optional Features

- Master nurse call
- Emergency phone
- Monitoring/CIC equipment, etc. (on back or adjacent wall)
- Wall protection
- Sign to clearly identify station

MEDICATION ROOM

These rooms are used to securely store medications for easy access by authorized personnel.

Minimum Standards

- Door with key pad or card reader. Door shall include glazing.
- Sink with splash guard (see 064040-H – 'Architectural Woodwork')
- Omnicell with adjacent undercounter refrigerator
- Sharps container
- Work counter
- Computer + OMP + printer

- Critical power for Omnicell, refrigerator and OMP (provide normal power outlets for when repairs to critical power are required)
- Wire carts for storage
- Angled shelving
- Tackboards
- Hooks for IV prep
- Sheet vinyl flooring / base with painted walls

Optional Features

- n/a

NOURISHMENT ROOM

These areas are used to store and provide patient nourishment on inpatient floors. Access to these areas should be clear and convenient to the patient.

Minimum Standards

- Refrigerator (full or undercounter)
- Coffeemaker with instant hot water
- Ice Machine
- Sink – solid surface single bowl integral with countertop (see 064040-H – ‘Architectural Woodwork’)
- Paper towel and soap dispensers
- Waste & Recycling Receptacle
- Cold and hot drink cup storage
- Locked overhead/undercounter cabinets + drawer storage for surplus supplies and condiments
- Minimum 36” wide countertop

Optional Features

- Door on room
- Low level night lighting (multi-level)

SOILED UTILITY/SOILED HOLDING ROOM

This room receives and stores soiled items from clinic or inpatient areas. The room must be closed off from other clinic or inpatient areas to insure proper infection control measures are enforced.

Minimum Standards

- Door(s) with keypad or card reader (TBD during design)
- Stainless steel or solid surface counter with integral sink compartment
- Open compartment under sink (no storage)
- Open shelving above counter or wire carts
- Space for soiled carts + recycling and biohazard containers
- Wall protection (stainless steel, solid surface or vinyl, etc.)
- Floors should be vinyl tile or sheet vinyl with standard 4” wall base
- Standard fluorescent light fixtures with occupancy sensor

Optional Features

- Sheet vinyl floor with integral base if excessive water is used in this area.

CLEAN UTILITY/CLEAN HOLDING ROOM

This room type is used to store clean items/supplies for clinical and/or inpatient areas.

Minimum Standards

- Door(s) with keypad or cardreader
- Wire cart or plastic bin storage
- Quad outlets (minimum of two) for recharging equipment
- Data outlets
- Vinyl tile or vinyl sheet flooring with standard 4" wall base
- Painted walls
- Standard fluorescent light fixture with occupancy sensor
- Size of room depends on location within clinic/inpatient area – Generally 80 – 300 SF with minimum width of 6 feet

Optional Features

- n/a

CONFERENCE ROOM

This room type is used for meetings with multiple participants. Larger conference rooms may have video conferencing capabilities.

Minimum Standards

- Minimum size for conference room should be 10' wide x 12' long. Example: This size room has an 8-10 person capacity.
- Room size should not be less than 10 SF per person.
- Rectangular table or tables (can be ganged or simply abutted)
- Chairs around table should be arm chairs with casters
- Supplemental seating around perimeter of room should be stacking; casters preferred
- Markerboard (minimum of 4' x 4')
- Tackboard (minimum of 4' x 4')
- Clock
- Adjustable lighting level (dual switching for small rooms; dimming for large – 20 + occupants)
- Projection screen/overhead projector with data and power cabling in larger rooms
- Data outlets
- Credenza storage (for supplies or audio-visual equipment)
- Speaker phone
- Coat hooks
- Two large waste receptacles
- Acoustical considerations (keep conversation within room and attenuate sounds from entering room, i.e. sound attenuators on ductwork serving the space, as needed)
- Dedicated HVAC zone of control
- Door(s) with lite; key lock
- Carpeted floor; painted walls; acoustical ceiling

Optional Features

- Video conferencing capability
- Table top power/data access
- Podium
- Motorized projection screen
- Flat screen monitor w/anti-theft lock
- Wall mounted house telephone outside rooms with 20+ occupants
- Acrylic holder outside room for posting daily meeting schedule (Size: 8-1/2" x 11")

CLASSROOM

This room type is used primarily for teaching and should be set up for flexibility to accommodate various teaching styles (traditional instructor at front of class or circular set-up). Secondary use is for meetings.

Note: Lecture halls/auditoriums (building location and user specifics are not addressed in this SBA.)

Minimum Standards

- Classrooms should accommodate a minimum of 20 participants with a minimum of 10 SF per person
- Tablet arm chairs should be used (some accommodating left handed participants). Tablet arms should be able to swing out of the way if the participant chooses not to use it. Chairs should stack or nest and be easily movable for maximum flexibility.
- Podium for instructor w/adjacent power/data outlets
- Speaker phone
- Motorized projection Screen/overhead projector
- Video Equipment display/storage or credenza
- Markerboard (minimum two 4' x 6')
- Tackboard (minimum 4' x 4')
- Clock
- Data outlets (at podium)
- Door(s) with lite; key lock
- Adjustable lighting level fixtures (dual switch for small rooms; dimming for large)
- Two large waste receptacles
- Coat hooks
- Hard surface floors; painted walls
- Dedicated HVAC zone of control

Optional Features

- Narrow, rectangular folding tables and chairs in lieu of tablet arm chairs
- Video conferencing capability
- Folding tables and chairs in lieu of tablet arm chairs
- Power/data outlets at tables
- Flatscreen monitor w/anti-theft lock
- Wall mounted telephone outside room

CONSULTATION ROOM

A small room for a physician or other clinical support to discuss treatment, protocol and/or follow up with a patient and their family/caregiver. This often is accomplished via A/V equipment or paper format.

Minimum Standards

- Room size to comfortably accommodate 4-6 people in either lounge seating or around a table with chairs (20 SF per person). Room for A/V equipment.
- 4' x 4' markerboard
- 4' x 4' tackboard
- Small credenza or desk to accommodate computer (to be viewed by all in room) and paper storage (take away instructions, brochures, etc.)
- Binder bin or "slatwall" components
- Speaker phone
- Power/data outlets for A/V equipment/computer
- Flatscreen television monitor
- Variable light levels in room – both overhead and table lamps
- Acoustical privacy
- Carpet; painted walls

Optional Features

- Staff assist button
- Additional square feet depending on location (OR, ICU, ED, etc.)

ON-CALL ROOM

These rooms are sleeping/resting rooms for on-call residents. House Officers Association should be consulted before moving or renovating and for current contractual requirements for these rooms.

Minimum Standards

- Room to be located in proximity to inpatient floor or service unit
- Minimum size to be 80 SF (8'x 10')
- Room to accommodate one single or one bunk bed with ladder, small desk for computer, desk chair
- One phone per bed
- One computer per room
- Power/data outlets
- Coat hooks
- Lockable storage bins or lockers, one per bed. Full length lockers preferred
- Door with key lock or keypad lock
- Acoustical privacy

Optional Features

- Lounge chair/recliner
- Wall mounted television
- Designated toilet room in reasonable proximity to on call room
- Clock
- Reading lamp(s)
- Baseboard night light
- Door with card reader
- Toilet/shower – accessible from on-call room
- Small refrigerator

PATIENT WAITING ROOM/AREA

These rooms/areas are used by patients & visitors to wait for clinic or procedure visits. Patient privacy is important as is maintaining a clear view across the waiting area by reception/check-in staff. Accommodations must be made for varying levels of patient ambulation and ability.

Minimum Standards

- Provide at least 15 SF per person
- Supportive, comfortable and easily cleanable seating
- Some bariatric seating and some double seating for parents/caregiver and children/patient
- Occasional and end tables
- Coat storage (hooks or closet)
- Wall mounted television (controlled by staff)
- Tackspace for patient notices
- Magazine rack(s)
- Computer workstation(s) for patients/visitors
- Artwork
- Visual access to reception/check-in
- Power/data as appropriate
- "Hot phone" for patients (insurance verification, appt. scheduling, etc.)
- Direct and indirect lighting with dual switching
- Borrowed lite to corridor or lite in door
- Acoustical isolation
- Carpet; paint

Optional Features

- Refreshment station
- Wall protection/chair rail
- Lounge chair/recliner (inpatient rooms)

BILLING OFFICE

This office is used for patient consultation regarding matters of charges for services, arranging payment plans and other clinical financial matters.

Minimum Standards

- Office must be a minimum of 10' x 12' with two doors
- Door for patient access must have window to corridor or waiting room
- Door for billing clerk should be at back of office for exit away from office guest (security measure) with card reader
- Desk and workspace for billing clerk with desk chair
- Lockable binder bins above or behind desk
- Small office safe (stored under desk)
- Cash drawer
- Computer/printer
- Desk telephone
- Phone/data outlets
- Two guest chairs in front of desk
- General ceiling lighting with some lighting at work surface
- Acoustical privacy within office
- Carpet; paint

Optional Features

- Security buzzer/alarm system mounted to underside of desk (for clerk)

RADIOLOGY IMAGING ROOM

A suite of rooms for clinical imaging such as mammography, CT scans, fluoroscopy, etc. Usually consists of a control room, an imaging room and occasionally an equipment room.

Minimum Standards

- Minimum 9' high ceiling
- Shielding according to code or as required by equipment type, manufacturer and University physicist
- Minimum acceptable working clearance around equipment to be determined by manufacturer
- Room humidification to be controlled per manufacturer's recommendations
- Ground wire size to be in compliance with manufacturer's requirements
- Floor slab to be sufficient depth to accommodate floor trough to equipment type & weight
- Power sources to mechanical/electrical systems to be coordinated (both on emergency or normal power)
- EPO shall be open contact parallel configuration
- Data/power outlets to be specific to equipment
- Lighting to include direct and indirect fixtures and dimmable downlights
- Heavy duty door (See FPD Design Guidelines)
- Window blinds in control or imaging room
- Sheet vinyl flooring, paint on walls, vinyl wall protection
- Recessed pulls on cabinetry
- Wall sign listing existing shielding installed within walls, ceilings and floors of imaging room
- Handwash sink, paper towel and soap dispenser, waste receptacle
- Apron rack and coat hooks

- Guest chair (*note: in MRI room, no metal fasteners may be used in chair*)
- Step stool (to assist patient access to equipment)

Optional Features

- Automatic door operator
- Intercom between control and imaging rooms
- Cubicle curtain
- Sharps container/glove boxes
- View boxes
- Patient Lift
- Art panel in ceiling light fixture
- Isolated power supply
- Tack board/marker board

RADIOLOGY READING ROOM

A room with one or more reading stations for reviewing/diagnosing digital images.

Minimum Standards

- Minimum cubicle size 7' x 7' for each reading station
- Lighting – not to exceed more than one foot candle (or below)
- Provide appropriate lighting levels for housekeeping
- Sufficient lighting for exiting
- Full length black cubicle curtain (no mesh at top of curtain)
- Black or charcoal acoustical wall covering and black acoustical ceiling
- Dark carpet
- Additional sprinkler heads to coordinate with curtain layout according to code
- Arm and armless chairs at workstations
- Specialty workstations for digital imaging reading
- Adequate ventilation to coordinate with curtain layout
- Power/data to accommodate workstations
- Layout of fire alarm notification appliances to take into account acoustical surfaces, ceiling-to-floor curtains and dark finishes

Optional Features

- n/a

STAFF LOUNGE/BREAK ROOM

This is a space for multiple staff to rest, renew and/or lunch away from the work environment. The room should be enclosed for privacy and adjacent to or in the work area.

Minimal Standards

- Door with lock
- Occupancy sensors for lights
- Lounge seating and/or tables and chairs
- Sink + counterspace (*Note: soap and paper towel dispensers at sink*)
- Refrigerator with ice maker, microwave oven (mount on millwork shelf under overhead cabinet – deep enough to accommodate plug with dedicated circuit), commercial coffeemaker (per current UM contract).
- Restricted appliances: toaster oven and popcorn popper
- Space for drinking water dispenser (outlet needed) + water bottle storage
- Large waste receptacle and recycling bins
- Tackboard, markerboard and fire board
- Clock

- Coat hooks
- Sheet vinyl floor with rubber base; painted walls

Optional Features

- Dishwasher and/or garbage disposal
- Vending machine(s)
- Computer workstations
- Staff mailboxes and/or magazine holders
- Adjacent toilet room(s)
- Card reader (at door)
- House phone and/or nurse call staff station (intercom)
- Staff lockers (size to be determined on each individual project)

PUBLIC AND/OR STAFF TOILET ROOM

These rooms can be single occupancy or multiple “stall” toilet rooms.

Minimum Standards

- Single occupancy – sheet vinyl floor, rubber base, painted walls (semi-gloss)
- Multiple occupancy – ceramic tile floor and walls
- Acoustical ceiling tile
- Solid surface counter with integral sink with mirror above
- Soap dispenser
- Hand dryer and/or paper towel dispenser
- Stainless steel partitions; floor mounted with ceiling support
- Fold-down “purse” shelf within stall; coat hook within stall
- Toilet paper dispenser per current UM contract
- Lighting over mirror/sink; recessed cove lighting at back of stalls
- New construction: floor mounted bariatric water closet
- Renovation: address bariatric requirements for existing water closet
- Occupancy sensor

Optional Features

- Ceramic tile floor/wall in single occupancy toilet room
- Hard ceiling
- Hands free entry door for multiple stall toilet room
- Hands free plumbing fixtures (sinks, water closets & urinals)
- Diaper changing deck

BEHAVIORAL HEALTH AREAS

Minimum Standards

- Apply design principles from the latest version of the “Design Guide for the Built Environment of Behavioral Health Facilities”.
- All tamper resistant screws shall be the “snake eye” type.

SBA-M-H: UMHC PATIENT AND STAFF PROTECTION: FALLS, BARIATRICS, LOW VISION, ERGONOMICS

GENERAL:

In general, follow the guidelines below when specifying and designing facilities for UMHC. Unless specifically indicated otherwise, these guidelines are not intended to restrict or replace professional judgment. Comply with all building and accessibility codes listed in [SID-F](#) and [SID-F-H](#). However, note that codes are minimums, but may not be best practice.

Architects, Engineers, Equipment Planners and Interior Designers shall take patient and staff safety into consideration throughout the design of facilities.

Many patients have low vision, limited mobility, and/or medical equipment issues. Staff areas should be designed with ergonomics in mind.

Note that Safety Management Services and Nursing have guidelines and staff training on Safe Patient Handling.

PATIENT PROTECTION GUIDELINES:

Colors and patterns should be selected to clearly differentiate between floors and walls. Floor and wall patterns with sharp contrast should be avoided; however a contrast between floor and wall is desirable.

Corridor handrails should be provided in in-patient areas and outpatient settings where dictated by program. Note that sloped floors less than the code minimum for ramps may require handrails and intermediate landings to make travel ergonomic.

Designated barrier-free toilet and bathing facilities must meet code, but all patient toilet and bathing facilities should be equipped with grab bars. All patient showers should be equipped with built in, folding seats capable of supporting a minimum of 900 pounds.

All toilets should support a minimum of 1000 pounds, which requires they be floor mounted. Special bariatric toilets, capable of supporting even greater weights, should be considered where clinically appropriate.

Provide patient emergency nurse call pull cords in toilet rooms and in bathing facilities within clinical areas. Outpatient clinics should include these pull cords unless specifically not required by clinical and risk management review. Refer to UMHC door hardware design guidelines for emergency access requirements into patient toilet and bathing facilities.

The distance between the patient bed and the toilet facility should be minimized. Ideally a handrail should be installed between the bed and toilet facility. A nightlight should be provided to light the path. Do not install grab bars or towel bars on doors.

Slip resistant flooring and walk off mats should be specified. Loose walk off mats should not be provided.

All accessories and fixtures should be installed with in-wall blocking to secure the item to the wall. Exceptions would be small items that are not expected to bear weight, such as soap dispensers and hand sanitizers.

Seating choices in an area should accommodate bariatric patients, and include chair arms in many locations. Wheelchairs must be accommodated within the seating arrangement.

Additional clearances should be considered for oversized wheelchairs and transportation, and in bariatric service areas.

Glare should be minimized in materials, exterior windows, daylight control and in lighting selection. Within the sight path, maximum to minimum lighting levels should not exceed a factor of 10. Consider the effect of windows and finish materials.

Even small thresholds and building expansions joints can be problematic for patients and staff moving IV poles or other equipment, or using canes, crutches or walkers. Changes in floor elevation should be avoided; when unavoidable, care should be taken to create a smooth transition.

Many patients at UMHHC are in oversized wheelchairs or scooters, and spaces should be designed to accommodate them. Rooms accessed by patients should be provided with oversized doors per the door design guidelines, and consideration given to door hold open devices, automatic operators, and delayed closers.

To the greatest extent possible, all outpatient areas should be accessible by stretcher.

Staff and patient ergonomics, length of reach, and flexibility for individual ergonomics should be considered in the design, for example: reception desks, work stations, appliances and equipment locations, trash receptacles. Height adjustable treatment and transport surfaces should be included.

Safety Management Services has extensive information available on patient lift design and installation. For permanently installed lifts, consider:

- Structural design of the floor or roof deck above.
- Ceiling locations of sprinklers, smoke detectors, lighting and HVAC supply and returns, soffits, booms, telemetry and wireless repeaters, privacy curtain tracks, IV tracks and AV equipment.
- Wall location of cabinetry, AV and medical equipment in relation to the lift tracks and travel.
- An accessible location for the lift parking station with a dedicated electrical outlet, normal power, for charging.

In locations where mobile lifts might be used, working clearances and maneuvering space to operate the chosen devices, including:

- Turning radius
- Door and pathway width clearance
- Load/unload clearance at all transfer destinations.
- Smooth, level, low friction finished floor surface without significant threshold barriers or obstacles to allow free base movement during use.
- Retrieval clearance at high risk fall locations, to allow transfer of fallen patient from the floor.
- Compatibility of the furnishings with the base support of the lift.
- Storage area for each piece of equipment and accessories identified where it will be convenient and readily available.
- Electrical outlet for charging in storage location for all battery powered equipment.

At all locations where lifts or other SPH (Safe Patient Handling) equipment are used, storage should be planned for clean equipment, soiled holding space for soiled equipment, space for a laundry hamper for soiled slings and fabric equipment, staging area for clean delivery and soiled pick up.

At off-site locations, consider an on-site laundry washer/dryer or drying rack.

Point of service cleaning of safe patient handling items, including space to allow fabric items to hang to dry after disinfection.

Facilities should be designed to accommodate the future installation of patient lifts.

Any glass doors and guardrails should be designed to clearly indicate glass is present; i.e. patterns or other materials included in the design.

No power, data, other cords or other trip hazards should run across walking paths on floors.



- HOME
- ABOUT US
- PROJECTS
- MAPS & DETOURS
- MASTER PLANNING
- POLICIES & PROCEDURES
- SUSTAINABILITY
- SAFETY

- FOR U-M CLIENTS
- FOR VENDORS
- FOR U-M AEC STAFF

OUT TO BID

DESIGN GUIDELINES

CODES & REGULATORY AGENCIES

DESIGN DELIVERABLES

SUSTAINABILITY

SPECIAL INSTRUCTIONS TO DESIGNERS

SPECIAL BUILDING AREAS

OFFICE SPACE

TECHNICAL SECTIONS

STANDARD DETAILS

MASTER SPECIFICATIONS

PREFERRED MANUFACTURERS

HEALTH SYSTEM PROJECTS

EFFECTIVE DATE

BUILDING COMMISSIONING

CONTRACTS & AGREEMENTS

CONTRACTOR RESOURCES

OTHER LINKS

OFFICE SPACE

[Office Space Guidelines](#) enable General Fund administrative and academic units to decide more effectively how to assign and use office space when planning renovations and new construction or responding to pressing space needs. The guidelines provide space-per-person recommendations by position type, which are based on recent construction projects at the University and guidelines used by other universities and in the private sector.

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- HOME
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- POLICIES & PROCEDURES
- SUSTAINABILITY
- SAFETY

- FOR U-M CLIENTS
- FOR VENDORS
- FOR U-M AEC STAFF

OUT TO BID

- DESIGN GUIDELINES
 - CODES & REGULATORY AGENCIES
 - DESIGN DELIVERABLES
 - SUSTAINABILITY
 - SPECIAL INSTRUCTIONS TO DESIGNERS
 - SPECIAL BUILDING AREAS
 - OFFICE SPACE

TECHNICAL SECTIONS

- STANDARD DETAILS
- MASTER SPECIFICATIONS
- PREFERRED MANUFACTURERS
- HEALTH SYSTEM PROJECTS
- EFFECTIVE DATE

BUILDING COMMISSIONING

CONTRACTS & AGREEMENTS










































CONTRACTOR RESOURCES









































OTHER LINKS

TECHNICAL SECTIONS
















Technical Sections (CSI Divisions 1 -14, 21-23, 26-28) contains system specific design criteria and design approach. Sections are divided by CSI specification section number.

SECTION	DATE OF LAST UPDATE	PAST VERSIONS	REPLACES SECTION
1 GENERAL REQUIREMENTS	July 2014		

01141 Tree Preservation	July 2004 		
01730 Operations, Maintenance and Training	February 2008 	April 1995 	
013100 Coordination	July 2014 	April 1995 	
017329 Roofing Materials Cutting and Patching	June 2014 	April 1995 	
2 SITE WORK	November 2010		
02000 Sitework	November 2010 	September 2007 	
02215 Soil Erosion and Sedimentation Control	November 2010 	June 2007 	
02510 Walks, Roads and Parking Paving	November 2010 	July 2006 	
02665 Water Supply Systems	April 1995 		
02810 Automatic Lawn Irrigation	November 2010 	April 1995 	
3 CONCRETE	July 2014		
033000 Concrete	July 2014 	April 1995 	
4 MASONRY	March 2014		
042000 Unit Masonry	March 2014 	April 1995 	
5 METALS	April 1995		
051000 Metals	May 2014 	April 1995 	
6 WOOD AND PLASTICS			
7 THERMAL AND MOISTURE PROTECTION	July 2014		
07270 Air Barriers	January 2011 		
075000 Roofing Systems and Accessories	March 2014 	August 2010 	
078413 Firestopping	July 2014 	February 2008 	
079200 Joint Sealant	June 2014 	June 2012 	
8 DOORS AND WINDOWS	JULY 2014		
081416 Flush Wood Doors	July 2014 	February 2008 	
08370 Frames, Power Operated Doors	April 1995 		
08410 Aluminum Entrance and Storefront Systems	January 2012 	May 2011 	
08520 Aluminum Architectural Windows	January 2012 	August 2011 	
08710 Finish Hardware	October 2010 	February 2008 	
08800 Glazing	January 2012 	October 2010 	
08911 Glazed Aluminum Curtain Wall	November 2011 		

9 FINISHES	May 2014		
092116 Gypsum Board Assemblies	January 2014 	April 1995 	
095100 Acoustic Ceilings	July 2014 	February 2008 	
093000 Ceramic Tile and Waterproofing	May 2014 		
096229 Cork Flooring	May 2014 		
096500 Resilient Flooring	October 2013 	February 2008 	
099100 Low-Emitting Paint And Coating Products	August 2011 		
10 SPECIALTIES	January 2014		
102113 Toilet Compartments	January 2014 	February 2008 	
101400 Signage	March 2014 	July 2009 	
10520 Fire Extinguishers	April 1995 		
102800 Toilet Accessories	January 2014 	February 2008 	
11 EQUIPMENT	July 2011		
115313 Laboratory Fume Hoods, Bsc's, Specialty Hoods And Acid Flammable Cabinets	July 2011 	June 2004 	
12 FURNISHINGS	April 1995		
12345 Laboratory Casework	April 1995 		
122000 Window Treatment	March 2014 	April 1995 	
13 SPECIAL CONSTRUCTION	April 2003		
132100 Controlled Environmental Room	June 2014 	April 2003 	
14 CONVEYING SYSTEMS	February 2014		
140000 Conveying Systems – General Requirements	February 2014 	September 2012 	
14420 Wheelchair Lifts	February 1999 		
14425 Barrier Free Lifting Devices			
21-23 MECHANICAL	April 2014		
210000 Fire Protection	May 2003 	April 1995 	15300 Fire Protection
220000 Plumbing Design	April 2014 	July 1992 	15450 Domestic Hot Water15455 Water Booster Pumps
220010 Plumbing Specialties	April 2014 	February 2014 	15430 Plumbing Specialties
220020 High Purity Water Systems	December 2005 	July 1990 	15460 High Purity Water Systems
220513 Motors	September 2012 	April 2009 	15170 Motors
220514 Variable Frequency Drives	September 2012 	November 2008 	15960 Variable Frequency Drives
220519 Thermometers and Gauges	April 2014 	May 2003 	15130 Thermometers and Gauges

220523 Valves	April 2014 	April 1995 	15100 Valves
220553 Mechanical Identification and Painting	April 1995 		15190 Mechanical Identification and Painting
220719 Mechanical Insulation	April 1995 		15250 Mechanical Insulation
221113 Basic Piping Materials and Methods	April 2014 	September 2012 	15060 Basic Piping Materials and Methods15140 Pipe Hangers
230000 Basic Mechanical Requirements	June 2013 	January 2001 	15010 Basic Mechanical Requirements
230010 HVAC Design	June 2013 		15070 HVAC Design
230011 Fans and Accessories	September 2012 	July 1990 	15870 Fans and Accessories
230012 Air Filters	May 2007 	July 1990 	15885 Air Filters
230013 Air Handling Units	April 2014 	July 2005 	15855 Air Handling Units15850 Air Blending Devices
230014 Packaged Roof Top Air Conditioning Units	May 2003 	July 1992 	15780 Packaged Roof Top Air Conditioning Units
230015 Fan Coil Units and Blower Coil Units	April 2014 	May 2003 	15830 Fan Coil Units and Blower Coils Units
230016 Computer Room Air Conditioning	April 2014 	March 2004 	15785 Computer Room Units
230017 Window Air Conditioning Units	July 1990 		15784 Window Air Conditioning Units
230020 Duct System Design	September 2008 	February 2007 	15890 Duct System Design
230021 Terminal Air Flow Units	March 2009 		15896 Terminal Air Flow Units
230022 Grills, Registers, Diffusers and Air Balancing Accessories	April 1991 		15880 Grills, Registers, Diffusers and Air Balancing Accessories
230030 Laboratory Ventilation Design	January 2014 	June 2011 	15910 Laboratory Ventilation
230040 Hydronic Systems and Specialties	May 2003 	February 1999 	15515 Hydronic Systems and Specialties
230041 Pumps	April 2014 	October 2005 	15160 Pumps
230050 Chilled Water Systems	October 2005 	February 1999 	15680 Chilled Water Systems
230051 Water Chillers	October 2005 		15681 Water Chillers
230052 Cooling Towers	May 2003 	July 1992 	15710 Cooling Towers
230060 Mechanical Sound & Vibration Control	March 2004 	July 1992 	15240 Mechanical Sound & Vibration Control
230593 Testing, Adjusting and Balancing	September 2008 		15990 Testing, Adjusting and Balancing
230900 Mechanical Systems Controls	July 2013 	September 2012 	15975 Mechanical Systems Controls
230930 Refrigerant Monitoring System	March 2004 		15635 Refrigerant Monitoring System
232216 Steam Specialties	April 1991 		15525 Steam Specialties
26 ELECTRICAL	April 2014		
260500 Common Work Results for Electrical	October 2013 	August 2013 	16010 Basic Electrical Requirements
260513 Medium, Low and Control Voltage Cables	February 2005 	September 2000 	16120 Wires and Cables
260526 Grounding and Bonding for Electrical	March 2005 		16450 Grounding

260533 Electrical Materials and Methods	June 2003 	October 2002 	16050 Basic Electrical Materials and Methods
260543 Underground Services for Electrical Systems	October 2002 	September 2000 	16110 Underground Electrical Service
260800 Electrical Acceptance Tests	October 2009 	May 2009 	16950 Electrical Acceptance Tests
260933 Lighting Dimming Controls	March 2004 		16550 Lighting Controls Systems
261000 Medium Voltage Electrical Distribution	June 2003 		16305 High Voltage Distribution
261010 Electrical Power Systems	June 2003 	September 2000 	16300 Electrical Power Systems
261100 Unit Substations	February 2005 	March 2004 	16310 Unit Substations
262000 Low Voltage Electrical Distribution	July 2003 		16400 Service and Distribution
262726 Wiring Devices	March 2004 		16140 Wiring Devices
262900 Motor Controls	March 2005 		16480 Motor Controls
262923 Variable Frequency Drives	June 2003 	July 1994 	16156 Variable Speed Drives
262940 Heating Cables and Mats	July 2003 		16850 Heating Cables and Mats
263000 Engine-Generator System	May 2013 	May 2012 	16231 Engine-Generator System
264100 Lightning Protection	July 2013 	April 2006 	16670 Lightning Protection System
265100 Interior Lighting	March 2012 	November 2011 	16511 Interior Lighting
265600 Exterior Lighting	May 2008 	June 2007 	16521 Outdoor Lighting

27 COMMUNICATIONS	April 2014		
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272000 Voice and Data Communications	April 2011 	December 2004 	16740 Telecommunications System
273523 Emergency Two-Way Communications	January 1998		16760 Special Communications Systems
275313 Clock Systems	May 2012 	September 2000 	16730 Clock System

28 ELECTRONIC SAFETY AND SECURITY	April 2014		
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281600 Security Systems	July 1990 		16725 Security System
283100 Fire Detection and Alarm	December 2004 	April 2004 	16720 Fire Alarm System

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TREE PRESERVATION

Introduction

This document delineates requirements for tree preservation on the University of Michigan campus.

Tree Survey

A tree survey will be done as part of the pre-design work for campus development projects. The survey will show the locations of the existing trees located within the bounds of the site, as well as on any surrounding areas that may be impacted by the project. The Design Manager (DM), together with the University Forester (UF), shall categorize the trees on the survey as follows:

- Memorial trees (including tree tag #) and their associated plaques.
- Trees to remain and be protected.
- Trees that can be relocated (transplanted).
- Significant trees that can be relocated.
- Significant trees that can be removed.
- Trees that are not significant or are of low quality.

If the preliminary survey includes significant trees or memorial trees that are to be relocated or removed, it shall be submitted to the Associate Vice President for Facilities and Operations (AVPFO) for approval. The survey shall be accompanied by a written summary prepared by the DM, the UF and the University Planner that describes the significance of the trees and the reasons for relocation and/or removal.

The tree survey as approved shall be provided to the Architect/Engineer (A/E). The A/E shall develop building and site concepts that are in accordance with the requirements identified on the survey. Deviation from the tree designations and dispositions as shown on the tree survey will not be permitted.

Protection

Existing trees that are to be preserved shall be protected during all phases of the construction project.

Specific Procedures for Protecting Trees

- The Contract Documents shall identify all trees to remain and to be protected, including those outside the construction limit line. [The protective zone around each tree shall be clearly identified.](#) The protective zone for significant trees shall not encroach on the canopy dripline unless there is a compelling reason why this is not practical. In such a situation, approval for the deviation must be obtained from the UF.
- For other trees, the protective zone shall extend to the tree canopy drip line where possible.
- The Construction Documents shall instruct the Contractor that no activity, including parking or storage of materials, will be allowed within the protective zones, and that protective fences or other methods of protection will not be moved, removed, or altered.

- Include aeration and gator bags as remediation measures for trees that have been negatively impacted by construction.

Relocation or Removal

Relocation and transplantation of existing trees will be accomplished by either tree spade or by the balled and burlapped method. The UF along with the University Planner will determine the new location.

Removal includes cutting the tree down and debris disposal

Specific Procedures for Removal and Relocation

- During design the UF and DM will decide whether the removal will be done by in-house crews or by the Contractor.
- The project responsible for removing the trees will fund the cost of transplantation or permanent removal by cutting the tree down.
- If the Contractor is removing trees, include instructions that felled trees and all associated debris shall be removed from the project site within 24 hours.
- Replacement trees will replicate the individual or cumulative caliper of the trees removed. For example, two 5" caliper trees could be replaced with one 10" caliper tree or five 2" caliper trees. The replacement trees will be planted on the project site or elsewhere on campus as determined by the UF and UP.



COORDINATION

Scope

All work in ceiling spaces, mechanical rooms, reflected ceiling plans, etc. shall be coordinated to provide maximum accessibility. Consider additional drawing sections or extraordinary construction measures to assure this. Pay particular attention to this when the user and/or other design staff have consciously decided to install mechanical equipment in marginally accessible locations.

Ladders, Catwalks and Platforms

Ladders, stairs, catwalks and platforms should be provided to areas where access is required for inspection or maintenance. Access to fans, balancing and flow control dampers, steam traps, sanitary clean outs, and sensors located high above suspended ceilings are particularly important. Do not rely on walking across duct work to reach these components.

Catwalks and / or platforms should be provided in accessible shafts and plenums for inspection maintenance and/ or future modifications.

In Mechanical rooms arrange ceiling suspended fans with clearance below to allow access from a jack stand.

Drawing Requirements

The A/E must place notes on the drawings, as appropriate, directing the Contractors to coordinate all work to allow free access to mechanical and electrical equipment for servicing. Particular attention must be given to assure access to panels, doors, service entrances, etc.

The removal of other components such as light fixtures in order to service any equipment shall be discouraged. Access routes should not encourage abuse (i.e., stepping on ductwork). The specifications should require that coordination drawings be submitted by the General Contractor for major renovation and new construction projects. These drawings shall clearly show the priority by trade required to assure access to the equipment and devices in the ceiling cavity. Of particular importance is the free access to all variable volume boxes, reheat coils and their controls -- including free and easy removal of the entire box. Nothing shall be located beneath these devices. (Fire protection or other piping is to be offset around the device footprint, etc.) The A/E must witness the construction to assure that the required accessibility is achieved.

Design Professional shall mark access panel locations on plans to promote coordination.

OPERATIONS, MAINTENANCE AND TRAINING

General

For University of Michigan Hospitals and Health Centers projects refer to Design Guideline 01730-H available at:

<http://www.med.umich.edu/facilities/planningdevelopment/ae/dg/arch.html>

Operations and maintenance costs are of prime concern to the University and thus the A/E shall design the systems to be both energy efficient and easily maintainable.

Where justifiable and appropriate, systems and components are to match existing. A written justification for sole-sourcing is normally required in such cases.

Systems are to be simple to operate and designed to fail in the least harmful position.

Protect mechanical and electrical services from physical abuse. Provide permanent access routes as appropriate.

Show on plan and elevation drawings required clearances at equipment needed for maintenance.

Related Sections

U-M Design Guideline Technical Sections:

[Section 15010 - Basic Mechanical Requirements](#)

U-M Master Specification Sections:

[15975 Mechanical Systems Controls - for service manuals for digital control systems](#)

Training Requirements

The A/E is responsible for meeting with the U of M Maintenance Manager (contact the University Project Coordinator) early in the design phase of the project in order to determine the number of training sessions required, and to reflect this in the construction specification. Most training should be conducted both in a classroom and at the system/equipment location.

The need for training will vary, in part depending on the complexity of a system, its uniqueness (at the U of M) and the familiarity of the area maintenance staff with that system, material or application.

For particular equipment, materials or components, the Contractor or supplier will normally conduct training. For complex systems such as HVAC systems, special lighting controls or communications systems, the A/E must conduct the training so that the design intent can be fully explained. It may be appropriate for systems training to be conducted jointly with a major vendor (e.g., the automatic temperature controls contractor may assist the A/E in presenting an HVAC training session).

Operating and Maintenance Instruction Manuals

Four sets of **job specific** operations and maintenance manuals shall be provided for each project. The construction specifications shall require the contractor to submit job specific O & M manuals a minimum of two (2) weeks prior to any scheduled training. The manuals shall be collected in indexed three ring binders and contain manufacturer's operating and maintenance literature for every equipment item furnished for the project. Generic wiring or piping schematics are NOT acceptable; they must be job specific, reflecting the actual furnished equipment, including all options and interfaces with other equipment or systems.

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ROOFING MATERIALS CUTTING & PATCHING

Scope

In general, follow the guidelines below when specifying cutting and patching of roofing.

Related Sections

U-M Design Guideline Sections:

[075000 Roofing Systems and Accessories](#)

U-M Master Specification Sections:

[017329 Cutting and Patching](#)

Reference Documents:

National Roofing Contractor's Association "Roofing and Waterproofing Manual"

Design and Installation Requirements

Important considerations to remember when specifying roofing cutting and patching are:

Warranty patching work must be performed in a manner which will not void the manufacturer's warranty. Installers must be licensed by the roofing manufacturer to perform patching work. All AEC/ Construction Services improvement projects affecting newer roofs within the first 2 years of installation shall contact the original installers. They carry the 100% labor/ materials repairs. After 2 years the contractor shall be a licensed applicator for the manufacturer for the remaining years on the roof warranty. Design Manager shall provide existing roofing system manufacturer and warranty information.

For asbestos test cuts, worker must have certification for asbestos sampling. Contact OSEH for coordination and procedures.

Roofing contractor shall provide min. 2 year workmanship warranty for patching.

Include the following information in project specifications:

Quality Assurance article of the cutting and patching specification:

Installer Qualification:

Arrange for cutting and patching of roofing systems by firm experienced in similar work, and licensed by manufacturer of roofing system to perform required repair work.

Pre-Construction Conference:

CUTTING AND PATCHING

017329

PAGE 1 OF 2

Contractor to arrange, through the Construction Manager and attend a meeting with a representative of roofing firm to determine procedures for cutting and patching roofing system.

In the "Part 2 - Products" portion of cutting and patching specification, include your standard language conveying the following ideas:

Use materials for patching identical to existing materials. Use materials for patching that result in equal-or-better performance characteristics.

In the "Part 3 - Execution" portion of cutting and patching specification, include the following requirement:

Before cutting and patching roofing materials, obtain the Construction Managers approval to proceed.

SITE REQUIREMENTS

General

In general, follow the guidelines below when designing and specifying sitework. Unless specifically indicated otherwise, these guidelines are not intended to restrict or replace professional judgment.

Related Sections

U-M Design Guidelines

[01141 Tree Preservation](#)

[02215 Soil Erosion and Sedimentation Control](#)

[02510 Walks, Roads and Parking Paving](#)

[02810 Irrigation](#)

[SBA-B Loading Docks](#)

Related Documents

[University Planner's Office Stormwater Best Management Practices](#)

[University Planner's Office Site Furnishings Standards Manual](#)

[University of Michigan Soil Erosion & Sedimentation Control Procedures](#)

Design Requirements

All work within City of Ann Arbor street right-of ways shall be in accordance with the City of Ann Arbor's standards and requirements. Permanent construction within City of Ann Arbor right-of-ways requires licensing by the City. Permanent construction on land not owned by the University may require an easement. Early in design, notify the University Design Manager of any such construction so that discussions with the City and/or other affected property owners can be initiated. Coordinate communications with the City through the University Design Manager.

All water main and sewer connections to City of Ann Arbor facilities shall be in accordance with the City of Ann Arbor's Standards and Requirements. Coordinate communication with the City Engineer regarding interpretation of these Standards and Requirements through the University Design Manager.

All materials, equipment and construction for bituminous and concrete pavements shall be in accordance with the latest version of the Michigan Department of Transportation Standard Specifications for Construction.

Granular materials shall be a minimum of MDOT Class II, compacted to 98% of an ASTM 1557 value.

All concrete shall be 4,000 pounds per square inch minimum compressive strength at 28 days, and consist of air entrained Portland cement with a total air content of not less than 4 percent, but

not more than 7 percent. Cement content shall be a minimum of 6 sacks per cubic yard. The slump shall be not more than 4 inches, nor less than 1-1/2 inches as determined by the slump cone test, ASTM C-143. All flatwork concrete shall be reinforced with polypropylene fibrillated fibers at a volume of 1.5 pounds per cubic yard.

Backfill for all utility trenches that run under, or within 3 feet of, existing and proposed concrete or asphalt surfaces shall be granular material as specified in (4) above.

All regular sidewalks should be 8 feet wide, and all steps and stairs eliminated if at all possible to facilitate barrier free access, cleaning and snow removal.

Paved areas at building entrances should be adequate to accommodate refuse containers.

The potential for installing an automatic lawn irrigation system should be discussed with UM Grounds Services, coordinated through the University Design Manager, early in the project, so that plumbing for the meter, back-flow equipment and a supply line to the outside of the building can be included in Mechanical work. See Design Guideline 02810 Irrigation for additional information.

Wall hydrants to receive a 1 inch hose should be included in the Mechanical work even if an automatic lawn irrigation system is planned for the project.

Stormwater management strategies should be included early in the design process. The A/E should consult with the University Design Manager and the University Planner's Office to determine the appropriate measures to reduce the amount of runoff. Refer to the University Planner's Office [Stormwater Management Best Management Practices](#) and the [OSEH's Stormwater Management Program Plan](#) for procedural information.

Site Elements

The A/E shall identify on the existing conditions site plan and on the demolition plan all site elements that will be impacted by construction, to include but not limited to:

- Free-standing building ID signs
- Plaques on the grounds or on the building
- Public art works and artifacts
- Kiosks used for posting flyers
- SORC posting boards (triangular boards used for posters)
- Memorial benches
- Memorial trees

The A/E and the University Design Manager will work with the University Planner's Office to determine the appropriate disposition of these site elements. It will be the responsibility of the project to relocate, replace, or restore the elements per the instructions of the Planner's Office. The A/E will stipulate in the design documents the approved disposition/relocation/restoration of

all relevant site elements. Refer to the University Planner's [Office Site Furnishings Standards Manual](#) for more information.

Refuse Removal

The A/E shall stipulate in the Design Documents that the Contractor shall remove all building materials and debris from the job site, and sub-grade the landscape areas to 4 inches below finish grade. Refuse removal during the construction phase shall be as frequent as necessary to prevent windblown debris. Unsightly pileup is also prohibited.

The construction site and valuable landscape plants shall be fenced to control Contractor parking and material storage.

Existing trees and other landscape plant materials within and outside the contract limits must be protected from soil compaction and breakage. See [Design Guideline 01141 Tree Protection](#).

Landscape plants and materials to be removed must be approved by the University Design Manager.

SOIL EROSION AND SEDIMENTATION CONTROL

General

In general, follow the guidelines below when designing and specifying soil erosion and sedimentation control. Unless specifically indicated otherwise, these guidelines are not intended to restrict or replace professional judgment.

Related Sections

U-M Design Guidelines

[01141 Tree Preservation](#)

[02000 Site Requirements](#)

[02510 Walks, Roads and Parking Paving](#)

[SID-F Codes and Regulatory Agencies](#)

[SID-K Sustainable Design and LEED Requirements](#)

[SID-T Landscape Materials](#)

Related Documents

LEED Reference Guide for Green Building Design and Construction

[University of Michigan Soil Erosion & Sedimentation Control Procedures](#)

[University Planner's Office Stormwater Best Management Practices](#)

Summary

Soil erosion and sedimentation control (SESC) procedures are activities which are regulated by the State of Michigan on all U-M project sites that implement an earth change activity.

All earth changes of one acre or more or within 500 feet of Waters of the State require a plan that is in compliance with the Soil Erosion and Sedimentation Control Part 91 of Natural Resources and Environmental Protection Act Public Acts 451 of 1994, as amended. All other projects must provide a site plan and a description of the methods being employed to control run off and the resulting sedimentation which would otherwise enter the existing storm water system.

During the design phase of the Project, the U-M Design Manager, with the assistance of the A/E, will submit to U-M OSEH the Project Notification Form. A blank copy of this form is available at <http://www.oseh.umich.edu/pdf/guideline/SESCAppA.pdf>

Definition

“Waters of the State” includes the Great Lakes and their connecting waters, lakes, ponds, rivers and streams, which may or may not be serving as a county drain as defined by the drain code; or any other body of water that has definite banks, a bed and visible evidence of a continued flow or continued occurrence of water and wetlands regulated under Part 303 of Public Acts 451 of 1994.

Design Requirements

The A/E shall prepare the soil erosion and sedimentation control plans and specifications. Implementation of the soil erosion and sedimentation control plan including required maintenance during construction and final removal as directed in the plans is the responsibility of the Contractor.

The University of Michigan, Occupational Safety & Environmental Health (UM-OSEH) is designated as an "Authorized Public Agency" and is responsible for administration of Part 91 of Act 451. The proposed plans for soil erosion and sedimentation control must be submitted for review and approval to the U-M-OSEH and the University Planner's Office, prior to the beginning of any site work. Coordinate with the Design Manager.

Developing and Implementing the Plan

Governing Principles for All UM Sites Involving an Earth Change Activity

The following principles should be considered before construction, when developing a soil erosion and sedimentation control plan:

- Integrate the overall construction design and activities to fit the existing physical and vegetative features of the site.
- Specify the staging of construction and stabilization activities to minimize the area and duration of disturbance. This can be done by limiting the areas of heavy equipment access and staging/storage of materials; protecting high quality and environmentally sensitive areas; and avoiding excessive and unnecessary clearing and stockpiling of topsoil.
- Protect natural/intermittent streams and swales and maintain as a natural habitat/campus amenity by identifying and mapping natural drainage features and directing surface drainage to the natural features.
- Reduce impervious surfaces by minimizing the dimension or area required for roads, drives, walks and parking.
- Specify control measures that will minimize erosion as a first line of defense, such as: seeding & mulching, preserving vegetative buffers, surface roughening, grade stabilization structures, check dams and controlling wind erosion by covering stockpiles or wetting exposed soils.
- Include perimeter protection controls that will prevent off-site sedimentation. Ex: perimeter barriers (silt fence), vegetative filter strips, anti-tracking pads, storm drain inlet protection, and sediment basins. Sedimentation control should not be used as a substitute for erosion control, but rather in conjunction with erosion control.
- Specify that a sweeper shall be employed to remove sediment tracked onto the pavement at least on a daily basis. Include a requirement that sweepers must be used more frequently, as needed, based on site conditions.

- Require the Contractor to establish an inspection and maintenance schedule.

Include as a minimum the following information for sites one acre or more in size or within 500 feet of Waters of the State:

- A map or maps at a scale of not more than 200 feet = 1 inch. Map shall include a legal description and site location, sketch that includes the proximity of any proposed earth change to lakes, streams or both; predominant land features including lakes, streams and wetlands; and contour intervals or slope information.
- A soils survey or a written description of the soil types of the exposed land area contemplated for the earth change.
- Description and location of physical limits of each proposed earth change.
- Description and location of existing and proposed on-site drainage and dewatering facilities.
- Timing and sequence of each proposed earth change.
- Description and location of all temporary and permanent erosion and sedimentation control measures, including timing on installation and removal of temporary measures.
- Program and schedule for maintaining all control measures.

A design and review checklist containing these required plan items is provided in Appendix B of U-M SESC Procedures.

<http://www.oseh.umich.edu/pdf/guideline/SESCAppB.pdf>

Recommended control measures for all U-M sites involving earth change activity:

The following SESC measures need to be included in all plans. Other measures may also be required based on specific site conditions and projects.

- Provide inlet protection on all adjacent and down gradient storm water inlets, catchbasins, and manholes. This may be accomplished using filter fabric, regular or high flow silt sacks, or other control measures.
- Install an entrance anti-tracking pad with a minimum of 50 feet in length. A geotextile filter fabric should be placed under 6 inches of limestone aggregate.
- Install perimeter barriers adjacent to and down gradient of the disturbed area.
- Place stockpiles and other spoil piles away from the drainage system to minimize sediment transport. Keep as few stockpiles as possible during the course of the project. If the stockpile and/or spoil pile must remain onsite overnight, or if the weather conditions indicate the chance for precipitation protect the pile from erosion.
- Provide dust control.
- Provide sweeping to remove any track-out.
- Specify biodegradable products for erosion control blankets.

Construction Sequence for all U-M sites involving earth change activity:

Include a construction sequence in the plans and/or specifications. The following construction sequence is recommended:

- Install all temporary and permanent erosion and sediment control measures in accordance with the approved plan and special permit conditions.
- U-M-OSHEM will inspect all projects at least weekly and after every significant storm events to evaluate the effectiveness of the control measures.
- Per plan and per U-M-OSHEM, maintain all temporary and permanent control measures daily and as needed based on the site inspections.
- Complete permanent soil erosion control measures for all slopes, channels, ditches, or any disturbed land area within 5 calendar days after final grading or the final earth change has been completed.
- Remove all temporary control measures after permanent soil erosion control measures are in place and the area is stabilized.
- Notify the Project Manager for a final inspection when the project is completed.

WALKS, ROADS AND PARKING PAVING

General

In general, follow the guidelines below when designing and specifying paving. Unless specifically indicated otherwise, these guidelines are not intended to restrict or replace professional judgment.

Related Sections

U-M Design Guidelines

[02000 Site Requirements](#)

[02215 Soil Erosion and Sedimentation Control](#)

[SID-K Sustainable Design and LEED Requirements](#)

Related Documents

LEED Reference Guide for Green Building Design and Construction

[University Planner's Office Stormwater Best Management Practices](#)

Design Requirements

All work within City of Ann Arbor street right-of ways shall be in accordance with the current version of the City's standards and requirements. During design, the A/E shall submit plans and specifications to the City for review and approval. This process should be completed prior to the issuance of 100% CD's.

All materials, equipment and construction for bituminous and concrete pavements shall be in accordance with the current version of the Michigan Department of Transportation Standard Specifications for Construction. No welded wire fabric shall be used in sidewalk construction.

In order to promote infiltration and an even distribution of stormwater flow, impervious surfaces should be minimized. The A/E should evaluate the site for potential pervious pavement/infiltration opportunities early in the design process. Consult with the University Design Manager and the University Planner's Office to determine the appropriate paving materials for each project.

Pervious Pavement Installation Requirements

Pervious pavement should not be located on top of recent fill or compacted areas, unless adequate under drainage is provided. Traffic type, pavement use, and type of loading should be considered in design, for example, dumpsters should not be located on porous pavement due to concentrated point load while emptying the dumpster.

Properly sized infiltration beds and under drains in locations with poorly drained soils should be incorporated. All porous paving installations should include an overflow system. This could consist of bleed-out pipes connected to sumps or outfalls into an unconventional or conventional stormwater system.

Utilize perforated pipes along the bottom of the filter bed to evenly distribute runoff. Infiltration areas should be located within the immediate project areas in order to control runoff at its source. Install compatible plantings adjacent to the pervious pavement that do not block the porosity.

Soil type (infiltration rate) and amount of water stored will determine the depth of the pervious pavement system. Frost depth should also be considered and the minimum filtration bed depth should increase accordingly.

“Vacuuming” the pavement should occur annually in order to keep the porous system operating at its potential.

Systems

- **Porous concrete:** Pervious pavement should be underlaid with a stone sub-base. Installation methods and outcomes should be carefully observed where grading requirements are stringent.
- **Porous asphalt:** Pervious asphalt should be placed directly on the stone sub-base in a single layer and rolled into a finished surface. This system is best used for parking lots, walkways, and in natural areas.
- **Porous concrete unit pavers/paver blocks:** This system is best used in high-visibility areas such as courtyards and plazas, as well as sites containing heavy loads, such as parking lots, service areas and low-speed drives. Accessible ramps within porous paver areas should use standard concrete to achieve and maintain the required grade.

Impervious Concrete Installation Requirements

Concrete shall consist of air entrained Portland Cement with a total air content of not less than 4 percent but not more than 7 percent. Cement content shall be a minimum of 6 sacks per cubic yard. Concrete shall contain polypropylene fibrillated fibers at a volume of 1.5 pounds per cubic yard

All regular sidewalks shall be 8 feet wide and 8 inches thick, and all steps and stairs eliminated if at all possible to facilitate cleaning and snow removal.

Paved areas at building entrances shall be adequate to accommodate refuse containers.

Where possible, impervious surface drainage should be directed to water receiving landscape areas such as lawns and planted areas.

Quality Acceptance Test

Minimum concrete 28 day compressive strength shall be 4000 psi.

Slump shall be not more than 4 inches, or less than 1 1/2 inches, as determined by the slump cone test specified in ASTM C-143.

Cleanup Requirements

Concrete and asphalt work (including cutting, grinding, drilling, and hyro-demolition) washout cannot be discharged into storm drains, catch basins or to the sanitary sewer system.

Direct the Contractor to utilize proper disposal and washout practices and to perform washing of concrete trucks in designated areas or offsite.

WATER SUPPLY SYSTEMS

General

The City of Ann Arbor's local plumbing codes supplement the State and National codes. Consult the City Engineer through the University Project Coordinator for specific interpretation.

The purchase of the water meter is the responsibility of the University; however, installation will be by the City. The Contractor is responsible for obtaining all necessary permits. The water use and sewer use fees for the water meter will be the responsibility of the University.

Related Sections

Tab "Special Instructions to Designers" - Section "F - Codes and Regulatory Agencies"

Tab "15" - Section "15010 - Basic Mechanical Requirements"

Tab "15" - Section "15060 - Pipe and Pipe Fittings"

Material Requirements

Materials from the City main to the entrance into the building shall meet City of Ann Arbor requirements.

Piping inside the building downstream of the City water meter should be copper. Brass nipple and/or dielectric flanges shall be used between dissimilar metals. Dielectric unions are not acceptable.

Installation Requirements

An approved backflow preventer shall be installed at the point of entry in new buildings, and at the point of take-off of new piping in renovation projects whenever the water is to be used for non potable purposes. See Section #15430. Backflow preventers shall be tested and certified upon installation of unit.

All fixtures connected to purified water systems shall contain approved vacuum breakers.

The A/E shall consult with the University Project Coordinator to determine if the existing building distribution system is sufficiently large to support the new demands.

All water pipes should be pitched to facilitate complete drainage.

Water hammer arresters should be installed at all fixture groups.

Newly installed pipes should be cleaned and chlorinated. The method used should be as set forth in AWWA Standard Specifications, latest edition, including all amendments thereto. The treatment should consist of a solution of not less than 50 ppm of available chlorine (liquid chlorine or sodium

02665

hypo chloride). After sterilization the system should be flushed with clean water until the chlorine residual is not greater than 0.2 ppm.

The high oxygen content of Ann Arbor water should be compensated for. One acceptable method is treating with sodium silicate prior to occupancy.

System must pass inspection by City of Ann Arbor.

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IRRIGATION

General

In general, follow the guidelines below when designing and specifying irrigation. Unless specifically indicated otherwise, these guidelines are not intended to restrict or replace professional judgment.

Related Sections

U-M Design Guidelines

[02000 Site Requirements](#)

[02215 Soil Erosion and Sedimentation Control](#)

[SID-K Sustainable Design and LEED Requirements](#)

[SID-T Landscape Materials](#)

Related Documents

LEED Reference Guide for Green Building Design and Construction

[University Planner's Office Stormwater Best Management Practices](#)

Summary

Careful consideration should be given to the selection of plant materials that require less water to sustain their life. In addition, the designer should consider context when preparing landscape plans to ensure an investment in an irrigation system is warranted and if so, that an appropriate level of care will be provided. For example, a landscape within a high image area may be more richly planted than an area that is seldom viewed by the public. U-M Grounds Services maintains a map of maintenance zones that can serve as a guide for where irrigation (or intensity thereof) is appropriate to include

(http://www.plantops.umich.edu/grounds/service_levels/priority/).

When irrigation is warranted, the U-M is committed to installing water efficient irrigation systems with metering equipment and other high-efficiency irrigation technologies to reduce potable water consumption whenever possible.

Design Requirements

The A/E should consider efficient technologies including Maxicom or similar irrigation management systems.

In addition to irrigation design, the A/E should provide plumbing, electrical and mechanical systems design for associated irrigation components within the building envelope. Separate meters for irrigation measurement should also be included.

The A/E should consult with the U-M Grounds Services for site specific irrigation needs.
Coordinate with the Design Manager.



CONCRETE

Scope

In general, follow the guidelines below when designing and specifying concrete work including structural, slab on grade, site work, sidewalks, etc.

Related Sections

U-M Master Specification Sections:

[033053 Miscellaneous Cast-in-Place Concrete](#)

U-M Design Guidelines:

[321000 Walks, Roads and Parking Paving: Sidewalks](#)

[093000 Cermic Tile and Waterproofing](#)

Design and Installation Requirements

Design Requirements

Structural Elements: ACI 318, designed for calculated structural requirements. A/E's may use their own office standards for details such as chamfered vs. square edges. Include the following language in specifications:

Water shall not be added to concrete at the jobsite.

Floors, General: The University supports the use of floor flatness and levelness "F-numbers" as described in ASTM E 1155-87 and ACI 117. Flatness and levelness specified in terms of "1/8-inch in 10 feet" or similar descriptions are difficult to enforce. Job-site quality control will be provided by a testing firm engaged and paid for by the Owner, unless otherwise determined by the Design Manager.

Strength: As required, but not less than 3500 psi at 28 days.

Flat Slabs-On-Grade: Design slabs-on-grade to comply with the following requirements:

- Vapor Barriers: Usually required. Omit vapor barriers only in consultation with Design Manager. The practice of perforating vapor barriers to avoid the phenomenon of "slab curling" is not acceptable.
- Thickness: Comply with the following:
 - General: 4 inches, or greater if required by expected live load.
 - Mechanical Rooms: 5 inches, or greater if required by expected live loads.
 - Strength: As required, but not less than 3000 psi at 28 days.

Equipment Bases and Foundations:

- Minimum Compressive Strength: 4000 psi at 28 days.

Finishes:

- Chamfer exterior corners and edges of permanently exposed concrete.
- Mechanical, electrical, storage rooms etc. shall have clear sealed finish. Rooms that are typically unoccupied and have an exposed concrete floor shall be sealed for easier maintenance.
- Include moisture, alkalinity and adhesion testing in specifications to verify concrete is cured appropriately to accept finishes.

Floor and trench drains:

- Design professional shall provide details, minimum 3"=1'-0" for each type of floor or trench drain. Detail shall include termination of surface finish materials, crack isolation membranes, and waterproofing materials.



UNIT MASONRY

Scope

In general, follow the guidelines below when designing and specifying clay and concrete masonry and accessories. Unless specifically indicated otherwise, these guidelines are not intended to restrict or replace professional judgment.

Design and Installation Requirements

Face Brick Selection

Brick Selection Process: The Design Manager will coordinate brick selection with the A/E, University Planner and University Architect. Brick selection prior to bidding is required. If cash allowances must be included, be sure to provide for special shapes. Cash allowance prices must be approved by the Director of Construction Management before bidding. Typically the selection process is as follows:

- Step 1 - Early in design phase, determine if a brick selection is required. Discuss with A/E, University Architect and University Planner to determine the criteria / objectives of the selection.
- Step 2 - The A/E shall contact several brick suppliers and formally request a submittal that will meet the criteria/objectives determined in step 1. The brick supplier's submittal shall include a thin 1' x 2' sample and a statement of unit cost along with any necessary specification data.
- Step 3 - The A/E will compile the submittal information and eliminate any submittals that clearly do not meet requirements or criteria. The remaining choices shall be reviewed at the site with the Design Manager, University Architect and University Planner.
- Step 4 - The suppliers of the acceptable samples shall be requested to build a mock-up panel 4' x 4', at the site, for final selection.
- Step 5 - Chosen samples (should seek a minimum of three) shall be included in the specification and bid as a part of the General Contractor's responsibility.
- Step 6 - The specifications shall call for the supplier of choice to build a 4' x 6' mock-up panel, at the site, that will be used for confirmation of match with mock-up panel referred to in Step 4, mortar selection, and installation workmanship. This final panel will be the panel used to measure appearance and workmanship for the project. The specifications must direct the General Contractor to construct the 4' x 6' mock-up panel to match the 4' x 4' panel and to meet certain workmanship criteria. This 4' x 6' mock-up panel must be reviewed and approved by the A/E and the owner. The General Contractor is entitled to include any of the specified brick material in his bid price. In addition, specify that the General Contractor must remove all existing mock-up panels from the site by the completion of the project.

Face Brick Specification

General: Brick complying with the ASTM C 216 face brick standard is not necessarily durable in this climate, nor suitable for installation in every season; nor does C 216 address the important issue of initial rate of absorption. Consequently, the University requests A/E's to modify ASTM C 216 as indicated below.

Modifications of ASTM C 216: Modify face brick standard as follows:

- Strength - As determined by the A/E.
- Type and Grade - Both type and grade must be clearly specified, since the ASTM C 216 default values are not acceptable:
 - Type - Suitable for architectural effect intended, but if other than FBX, coordinate with Design Manager.
 - Grade - SW, in all applications.

ASTM C 216 Table 2 "Physical Requirements" - Add the following Initial Rate of Absorption requirement:

- Initial Rate of Absorption - Not more than 22 gram/min./30 sq. in.; where cold weather installation is anticipated, not less than 6 gram/min./30 sq. in.
- If, during selection process, face brick with an IRA higher than 22 gram/min./30 sq. in. is selected in order to match existing face brick, limit the average saturation coefficient to less than 0.74, or alternatively, limit absorption to 8.4 percent. Brick outside these limits has a higher potential for durability problems.

Coring - Modify Article 10 to delete frogged brick. Frogged brick is not permitted since incompletely filled cavities permit moisture to collect, possibly freezing, lifting brick and destroying mortar bond. A 3-core pattern is preferred over other patterns, whenever possible, for improved mechanical keying.

Waivered Brick: Where face brick that has been waived under ASTM C 216 is selected in order to match existing face brick, require manufacturers to submit written certification of acceptable past performance in the local climate.

Finishes Over Face Brick: Do not include painting or waterproof coatings such as silicone over clay masonry units. Specify that brick units with factory applied silicone coatings are not acceptable.

Installation: Some brick exhibits a wide range of color between those brick near the outside of the stack during firing, and those near the inside. Unless masons take care to mix these brick at the site, the resultant effect may be an unpleasant grouping of dark and light colors. Consequently, for brick susceptible to this phenomenon, require that brick be broken out of pallets and intermixed on the site before installation, to ensure pattern randomness.

Cleaning: Avoid specifying acidic cleaners for masonry in areas adjacent to stone surfaces, and where existing landscaping materials may be damaged by run-off.

Concrete Masonry Units (Block)

Standards: No special standards beyond ASTM C 90 requirements.

Mortar for Unit Masonry

Mortar: The University accepts the use of either Portland cement/lime mortar or masonry cement mortar. Calcium chloride is not permitted as an additive.

Mortar Spreading Technique: Specify that mortar be spread using the "beveling" technique described in BIA 21C-78. Beveling helps keep cavities free of mortar droppings, and assists in filling 3-hole brick cores.

Joints: Specify tooled joints in masonry exposed to weather. Avoid the use of raked, struck, or other similar joints in masonry unless units will not be exposed to weather. Require full head joints on brick masonry.

Flashing

Lead and asphalt coated lead materials are not acceptable due to the reputed incompatibility of lead and mortar, and potential toxicity issues. PVC and similar plastic flashings are not acceptable due to brittleness problems caused by stress or loss of plasticizer.

Installation: The following requirements are based on BIA and NCMA recommendations: Mechanically attach flashings to substrate for support. Adhesive attachment is not acceptable. Extend flashing over openings at least 4-inches beyond opening sides and form ends into dams. Carry flashing out of wall to ensure proper function. Because manufacturers of asphalt coated or rubberized asphalt flashings require their products to be cut off 1/2-inch behind the wall face, combination flashings consisting of rubberized asphalt sheet terminating in metal through-wall flashing pans is recommended.

Thin Brick

Installation and use of thin brick products are an option for interior applications only. Care shall be taken in pattern layout and jointing to preserve the look of full depth masonry.

Thin brick installation is not accepted in exterior applications.

Miscellaneous

Weep Holes: Construct weep holes in the head joints in exterior wythes of the first course of masonry immediately above embedded flashings and as follows:

- Form weeps by keeping head joints free and clear of mortar. Cotton wicks and plastic tubes are not acceptable.
- Space weep holes 24 inches o.c.
- The use of brick vents for weep holes is not encouraged.

Cavity Drainage Materials: - Provide free-draining mesh, made from polymer strands that will not degrade within the wall cavity.



METALS

Scope

In general, follow the guidelines below when designing and specifying structural steel, metal deck, and metal fabrications.

Related Sections

U-M Design Guidelines Section:

[SID – F Codes and Regulatory Agencies](#)

Design and Installation Requirements

Structural Steel

Structural Steel Lintels and Shelf Angles - Lintels and shelf angles provided for support of masonry veneers exposed to weather must comply with the following requirements:

- Units must be hot-dip galvanized after fabrication.
- Units are not required to, but may be, stainless steel.
- Leg thickness must be sized for structural loads, but not less than 3/8-inch thick.
- All exposed structural steel, not encased in fire protection shall be painted.

Metal Roof Deck - All metal roof deck must be hot-dip galvanized (ASTM A 525 G60 coating).

Miscellaneous Metal Fabrications

Guardrails and Handrails - Specify hot-dipped galvanized steel for all exterior locations exposed to weather. Alternatively, stainless steel, bronze, anodized aluminum and other materials may be used with the approval of the Design Manager.

Handrails in concrete paving and walks may be set in sleeves or core drilled holes. Depth of core must be not less than 4-inches deep and of a diameter not less than 1-inch wider than outside pipe diameter. Set rails in non-shrink, erosion resistant grout.

AIR BARRIERS

General

Properly installed air barriers are critical to maximizing the thermal performance of the exterior envelope.

Specifications and details (where applicable) for air barriers should be included in both new construction and additions.

Related Sections

U-M Design Guideline Sections:

[SID-D Energy and Water Conservation](#)

[SID-F Codes and Regulatory Agencies](#)

Reference Documents:

ASHRAE 189.1 Standard for the Design of High-Performance, Green Buildings (current edition)

ASTM E 783 Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors

ASTM E 2357 Test Method for Determining Air Leakage of Air Barrier Assemblies

ASTM E 2178 Standard Test Method for Air Permeance of Building Materials

780 CMR 8th Edition Chapter 13 Proposed MA Front-End Amendments to the *International Energy Conservation Code 2009* (IECC 2006), Paragraphs 5.2.4.3 and 5.2.4.3.1.

Air Barrier Design Standards

Comply with the requirements of applicable building codes and the current version of ASHRAE 189.1. Current applicable codes for UM buildings can be determined by referring to the Codes and Regulatory Agencies page of this web site at the following address:

http://www.umaec.umich.edu/desguide/sid/sid_f.pdf

Design Requirements

Air barriers are required in the exterior building envelope of all new buildings and additions. Where a portion of the building contains unconditioned space which has conditions differing from those of the conditioned space by more than 50% of the difference between the conditioned space and design ambient conditions, a continuous air barrier shall also be provided between the conditioned and unconditioned spaces within the building.

Design a fully continuous air barrier for the entire building envelope capable of controlling air leakage into and out of the conditioned spaces. The air barrier assembly must be designed to withstand positive and negative air pressures due to design wind pressures, stack effect and fan pressures. Pay particular attention to the design of the air barrier at joints and points of intersection of two different building materials to maintain continuity. The design shall have enough strength and flexibility to accommodate differential movement of material

substrates. Design the air barrier to remain in continuous contact with its substrate material in the building envelope.

For additions, design a complete air barrier for the addition enclosure as described above. Where existing walls and/or roof construction abut the new addition, continue the air barrier through the wall or roof construction in order to prevent air leakage at the juncture between the new and old construction.

Drawings

Include complete detail drawings of all transitions, perimeter sealing around fenestrations, penetrations through the exterior walls by structural members, parapet walls, etc.

Specifications

Specifications should include instructions about prepping surfaces and any primers needed to insure proper adhesion of air barrier materials.

Include language for coordination of all trades whose work impacts the continuity of the air barrier. Reference the Air Barrier specification section in all of the affected trades.

Include in the specifications the requirement for a pre-installation meeting with mandatory attendance by all trades whose work is related to the air barrier.

Air Barrier Product Selection

UM does not have a preference for a particular type of air barrier or air barrier assembly. Select materials which are listed by the Air Barrier Association of America http://www.airbarrier.org/materials/index_e.php. It is acceptable to have a combined air barrier and vapor retarder; however, in this case the barrier must be located on the warm side of the building envelope.

The air barrier assembly must be durable. When it will be concealed within the building envelope, design it to last the lifetime of the building envelope.

In situations where flammable air barrier products adjoin a wall cavity, provide thermal protection which is in direct contact with the flammable material.

Inspection and Testing of Air Barrier Installations

UM will employ independent inspectors and testing for projects involving exterior envelope work. Consult with Design Manager regarding the scope of testing for the project.



ROOFING SYSTEMS AND ACCESSORIES

General

In general, follow the guidelines below when designing and specifying roofing systems. Unless specifically indicated otherwise, these guidelines are not intended to restrict or replace professional judgment.

Related Sections

U-M Design Guideline Sections:

[SID-D Energy Conservation](#)

[SID-F Codes and Regulatory Agencies](#)

[SID-R Fall Protection on Roofs](#)

[051000 Metals](#)

[Architectural Preferred Manufacturer List](#)

UM Master Specifications:

[Section 075316 - Chlorosulfonate-Polyethylene \(CSPE\) Roofing](#)

[Section 075323 – Ethylene-Propylene-Diene-Monomer \(EPDM\) Roofing](#)

Reference Documents:

ANSI/SPRI VF-1 External Fire Design Standard for Vegetative Roofs

ANSI/SPRI RP-4 2008 Wind Design for ballasted Single-ply Roofing Systems

ANSI/SPRI RP-14 Wind Design Standard for Vegetative Roofing Systems

Roofing Materials

General - Specify that roofing materials for a given project are provided by a single manufacturer, and that all accessory materials be approved by that manufacturer as necessary to obtain the manufacturer's warranty.

Preferred System - Fully Adhered, Single Ply, Black, Ethylene Propylene Diene Monomer (EPDM)

Alternative systems listed below may be preferred for specific applications, such as aesthetics, condition of installation, or chemical resistance. Consult with the Design Manager for advice and consent regarding the use of other systems.

Alternative Single-Ply Systems

- EPDM, White: When considering the use of fully adhered, single ply white Ethylene Propylene Diene Monomer (EPDM) to reduce heat island effects, energy modeling shall be used to determine potential savings for white (high-albedo) vs. black roofs. Discuss results of energy modeling with the Design Manager.
- EPDM, Inverted and Ballasted (IRMA) and CPE: Not acceptable.

- Hypalon (CSPE): Consider fully adhered hypalon systems when resistance to chemical attack is paramount, such as on roofs with a substantial number of fume hood exhaust stacks or where repeated exposure to oil or coolant fluid leakage is likely. Mechanically attached systems are acceptable when desirable for condition of installation.
- Poly Vinyl Chloride (PVC) and Thermo-Plastic Olephine (TPO) Membranes: Acceptable under vegetative roof systems only, 60 mils thick minimum.
- Atactic PolyPropylene (APP) and Styrene Butylene Styrene (SBS) Modified Asphalt Membranes: Not approved for use, except for small roof areas and patching.

Alternative Roofing Types - Other types of roofing systems that may be considered include natural slate, clay tile, asphalt shingle, and standing seam sheet metal roofs. There are currently no explicit University standards for these systems. Comply with manufacturer's and industry standards, and professional judgment for materials and installation.

- Composite materials with the appearance of slate or clay tile are generally not approved for use.
- Multiple-ply built-up asphalt roofing systems are not permitted on campus areas due to objectionable odors.
- Vegetative roof systems are new to the University and are used in select applications. Close coordination with Design Manager is required for system selection and detailing.

Vapor Retarder

Use of asphaltic vapor retarders are not preferred due to objectionable odors.

Walkway Protection - For single-ply roof systems, provide walkway protection from roof access points to all roof mounted equipment requiring routine maintenance. Walkway protection should generally consist of a minimum 100-mil thick EPDM or Hypalon membrane, to match roofing material.

Provide minimum of 4 sq. ft/ of walkway pad directly adjacent to equipment access panel for toolbox and parts to be set down during routine maintenance.

Insulation - Comply with SID-D requirements. Polyisocyanurate is the acceptable insulation material. Insulation products shall be 25 psi minimum. Provide insulation coverboard, 200 psi minimum.

Accessories

- Roof sumps - Specify all cast iron components.
- Roof and equipment hatches - Specify the following minimum requirements
 - Anodized aluminum hatches with insulated double wall lids and insulated double wall curb frames
 - Integral mounting flange and counter-flashing.
 - Heavy duty stainless steel hardware.

- Access ladders - Specify galvanized steel ladders fabricated from tube steel side rails with 1-3/4" tread grip rungs. Extend side rails above top rung. Paint finish optional.

Quality Assurance

Pre-Installation Conference - Require conference for all University roofing projects, including small repair or penetration work. This conference should be attended by, at least, the general contractor, the roof installer, Design Professional and University Construction Manager.

Warranty Requirements - Comply with the following requirements for warranties:

- New Membrane Roofs, Single-Ply Systems: Require a 15 year, single source warranty covering the full roofing system (including all accessories) for materials and labor.
- New Membrane Roofs, Vegetative Roof Systems: Require a 30 year, single source warranty covering the full membrane/waterproofing system (including all accessories) for material and labor.
- Repairs/Modifications: For roofs still under warranty, require that the original manufacturer's material be used and that the installer be approved by the manufacturer. Contractor should notify roofing manufacture with the warranty and the U-M roofing shop in writing of the changes to the roof under warranty.

Design Requirements - New and re-roofing projects

General

- Provide access to all areas of roof.
- All roof work should be watertight and weatherproof, on a daily basis, before contractor leaves the project site.
- Project must comply with the requirements outlined in SID-R Fall Protection on Roofs.

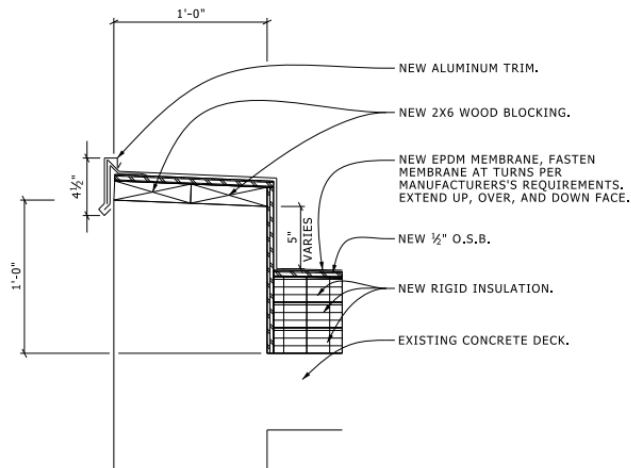
EPDM, White Roofs (and other high albedo roofing systems) – An energy model shall be completed to determine payback and reviewed with the Design Manager. Also, ensure that the following conditions are met:

- Provide dewpoint calculations.
- Specify conductors and wiring, used to control rooftop HVAC equipment, capable to withstand reflected heat from the roof.
- Design placement of rooftop equipment to prevent ice buildup and additional risk for maintenance staff.

Flat Roof Design - Generally comply with good roofing design practices outlined in the NRCA "Handbook of Accepted Roofing Knowledge". Specifically, ensure that the following conditions are met:

- Slope roof as required by Code and not less than 1/4-inch per foot. Pitch roof by either sloping structure or by using tapered insulation.

- Slopes to drain should be unobstructed by above-roof building elements, equipment curbs, or similar objects. Where such obstructions are unavoidable, provide cants, saddles or other means to restore positive pitch to drain.
- Maximize parapet heights and run single-ply roofing materials up, over the top and down the face of parapets beneath stone coping caps and beneath metal trim. Metal coping caps are not preferred.



- Optional Roof Edge Detail **ROOF EDGE DETAIL**
- Specify that no EPDM single-ply membrane field seams be located within 5 feet of sumps (3 feet for Hypalon).
- Specify that no buck laps are permitted anywhere in single-ply roofing membranes.
- Specifically reference Factory Mutual 1-60, 1-75, or 1-90 roof requirements, as appropriate for the application.

Vegetative Roof Design - Generally comply with good roofing design practices outlined in the NRCA "Vegetative Roof Systems Manual". Specifically ensure that the following conditions are met:

- Limit slope design to a 2 to 12 pitch. A sloped structure is preferred to achieve necessary roof pitch in lieu of the use of tapered insulation.
- Provide a 6 foot minimum continuous fire break around roof edge, rooftop structures and rooftop equipment that contain combustible vertical surfaces. Non-vegetative fire breaks should consist of an ASTM E108, Class A system.
- Provide an 18 inch minimum continuous break around roof edge, rooftop structures and rooftop equipment that contain non-combustible surfaces.

- Comply with all manufacturer requirements to maintain warranties for underlayment systems.
- Provide access to at least one fire hydrant.
- Underlayment systems should consist of, at a minimum, a waterproof membrane system, membrane protection, root barrier, drainage/water retention layer, aeration/water retention layer, filter layer and soil substrate.
- Install indigenous and/or adaptive plantings only.
- Inverted insulation systems are not acceptable. Insulation must be installed below the waterproof membrane; the compressive strength must be appropriate for the expected dead and live loads of the selected system.
- Waterproofing membrane should be fully adhered to the substrate, not mechanically fastened or loose laid.
- Membrane flashings should be a minimum of 4 inches above the surface of the growth medium.
- For existing buildings, coordination with a structural engineer is required to determine the live load capacity of the existing structure.
- Structures supporting vegetative roofs should have a minimum live load capacity of 100 pounds per square foot or meet the requirements of the code, whichever is more strict.
- Vector mapping systems are recommended, but not required. For projects including vector mapping, coordinate with the Design Manager.
- Where tray systems are used over an existing conventional roof membrane, membrane protection is required.
- Water test(s) of waterproof membranes prior to installation of subsequent systems is required. Coordinate with the Design Manager.

Equipment Supports - Generally, steel support frames are preferred wherever practicable, since curbs tend to interfere with roof drainage. Coordinate the following roofing issues with mechanical engineers.

Steel Frames: Steel angle, channel or wide-flange shape frames with pipe column supports. Comply with the following requirements:

- Carry support legs down to solid structural framing (i.e. steel joists or beams, or concrete beams or deck, if analyzed and known to be structurally adequate). Do not place support legs on metal deck.
- Column supports to be round or square tubes only.

- Minimize the number of legs. For example, use 1 support centered on a gang of pipes instead of 2 wherever possible.
- Design supports for not less than 18 inches clearance above finished roofing surface. 24-inches is preferred clearance where possible and aesthetically permissible for smaller equipment units that can be reached just past center of unit from each side.
- Larger equipment shall be mounted 36"-48" above roof surface to allow for re-roofing and repair of equipment from underside.

Curb Type Supports: Construct curbs of pre-fabricated metal or site-built, preservative treated, lumber.

- For length or width dimensions greater than 48-inches, provide a saddle at the high side of the curb (against direction of slope-to-drain) to prevent water ponding behind curb.
- Generally limit the longest dimension of curb to 60 inches. Use steel support frames where a longer dimension is required.
- Do not use open-ended (two-sided) curbs. These curbs make re-roofing beneath equipment impossible.

Special Requirements - Re-roofing Projects.

Noise and Vibration - Attachment of underlayment, insulation, and other roofing materials may cause noise and vibration problems. This is especially true for applications over concrete roof structures where the structure may transmit noise throughout the building. Consult Design Manager to determine whether special requirements for evening or weekend work are necessary.

Dust Protection - Specify the provision of dust protection over occupant's equipment and furnishings where appropriate. For example, specify protection for top floor areas that are occupied (not penthouses) and that do not have suspended ceilings. Where occupant's activities may be particularly sensitive to dust, specify protection regardless of presence of suspended ceiling. Note that dust protection should be applied and removed in coordination with occupant's operations. Consult Design Manager.

Special Requirements - Construction Projects Impacting Existing Roofs.

Quality Assurance

- Standards: Require cutting and patching work in compliance with University Roofing Department and with recommendations of the National Roofing Contractors Association "Roofing and Waterproofing Manual".
- Installer qualifications: Require that cutting and patching of existing roof systems is completed by contractor licensed by manufacturer of existing roofing system.

Temporary Roof Protection

- Require protective measures for areas of existing roof used for construction access, work, or material storage. $\frac{3}{4}$ " plywood tied together over 1 1/2" ISO insulation.

- Require filter fabric over roof drains.



FIRESTOPPING

Scope

For University of Michigan Hospitals and Health Centers projects refer to Design Guideline [078400-H: Firestopping \(078413-H\)](#).

Properly installed firestopping is critical to the successful fire performance of the building.

Specifications and details (where applicable) for firestopping should be included for both new construction and renovations, whether or not the renovation project involves new penetrations. Survey existing conditions for deficiencies in firestopping and unprotected wall openings, identifying both Code violations and other deficiencies. Present a summary to the Design Manager, who will determine the extent of remediation for each project.

Related Sections

U-M Design Guidelines:

[Codes and Regulatory Agencies](#)

Reference Documents:

Manual of Practice of the Firestop Contractors International Association (F.C.I.A.)

Design and Installation Requirements

Firestopping Design Standards

Include the Manual of Practice of the Firestop Contractors International Association (F.C.I.A.) in the "References" article of the specifications.

Firestopping Product Selection

Select products from recognized manufacturers which have been tested by one of the following three agencies: Underwriters Laboratories (UL), Omega Point Laboratories (OPL), or Intertek/Warnock-Hersey (WHI).

Include T and L ratings in addition to F ratings where applicable and/or where required by Code.

Floor Sleeves for Mechanical and Electrical Penetrations

Sleeves are highly recommended for floor penetrations to protect contents on the floor below the penetration from leakage or flooding caused by pipe breaks, sprinkler discharge, etc. In

deciding where floor sleeves will be required, the Design Manager will evaluate the level of protection desired in the project and the likelihood of water damage.

Require coordination by the firestop contractor with mechanical and electrical trades so that the proper firestopping systems are selected.

Drawing Requirements

Design Professional to provide project specific details minimum scale 3"=1'-0" of each firestopping installation.

UL Design numbers shall be included on firestopping details

Inspection of Firestopping Installations

Normally, inspection of firestopping installations will be carried out by UM inspectors. If there are special circumstances which require an independent testing/inspection agency, direction will be given by the Design Manager. If a testing agency is employed, include reference to it in the specifications.



JOINT SEALANTS

Scope

Material and installation requirements for Joint Sealants.

VOC content of joint sealants.

Related Sections

U-M Master Specification Sections:

[079200 – Joint Sealants](#)

U-M Design Guideline Sections:

[SID A Building Envelope](#)

Reference Documents:

[South Coast Air Quality Management District \(SCAQMD\) Rule 1168, Adhesive and Sealant Applications](#)

Design and Installation Requirements

General Design Requirements

For each joint, select products with a performance rating which matches the anticipated location, use and design movement of the joint. Detail joints with appropriate backing so that sealants will perform as designed.

To ensure proper adhesion in critical joints specify pre-construction adhesion testing by a certified independent laboratory. Specify primers when necessary to attain proper adhesion to the substrate.

For joint sealants within the weatherproofing envelope specify low-VOC products complying with SCAQMD Rule 1168.

- If the project is expected to encounter extreme temperature and/or humidity conditions, verify whether low-emitting sealants will meet the project's performance requirements. When an exception to the use of low-emitting sealants is proposed, describe in writing the reasons why low-emitting products will not perform adequately.

Provide a Joint Sealant Schedule which lists products for each type of joint, in addition to backing and primers, if required.

Provide details, minimum 3"= 1'-0" scale for each type of building envelope enclosure sealant joint and condition. Termination of vapor retarders and air barriers shall be included.

Fireproofing Joint Sealants

All joints in fire rated construction shall be detailed with a UL Design Number which matches the surrounding construction and the required rating.



FLUSH WOOD DOORS

Scope

In general, follow the guidelines below when specifying wood doors.

For University of Michigan Hospitals and Health Centers projects refer to Design Guideline [081400-H: WOOD DOORS \(08211-H\)](#).

Related Sections

U-M Design Guideline Sections:

081113 Hollow Metal Doors and Frames

[088000 Glazing](#)

Design and Installation Requirements

Design Requirements for Flush Wood Doors

Design

Generally, aesthetic considerations are the prerogative of the architect. Consult with the Design Manager concerning visual effects which do not correspond to general design features stated in this guideline.

Quality Standards

Either AWI or WDMA I.S.1-A should be referenced as the quality standard in the specifications. Reference the latest edition of whichever standard is used.

Construction

In general, manufacturer's standard products are acceptable, provided they comply with the following requirements:

- The University's standard interior wood door is solid core, of flush construction, and Custom grade. Consult with Design Manager before specifying stile and rail doors or other construction grades.
- 5-ply cores shall be provided. Lifetime warranty against delamination is required. Consult with Design Manager to determine appropriate quality level.
- Preference is for factory fitted doors.

Veneers

Do not specify exotic grades of wood with potentially long lead times and significant upcharges.

Glazing

For fire doors with lites, fire-rated safety glazing is required.

Wired glass is prohibited in door applications.

Factory glazing should always be specified for fire-rated openings and non-rated openings.

Finish

Specify factory finishing for transparent finishes. Factory finishing of adjacent wood frames is recommended to maintain a consistent appearance. Opaque finishes may be field painted but should be factory primed. Specify Medium Density Overlay in lieu of wood veneers for opaque finishes.

Fire Doors

Specify prefabricating and pre-machining for fire doors.

Hardware

Factory machine doors for hardware that is not surface applied.

Provide blocking for surface mounted hardware to eliminate thru bolts.

Thru bolts are only allowed at door pull applications.

Warranty

Specify a warranty period lasting the life of the door for flush wood interior doors. Do not design doors which will void the warranty because of oversized cutouts or insufficiently sized stiles and rails.

FRAMES, POWER OPERATED DOORS

General

The A/E shall engineer and specify the reinforcement of door and frame required to support the power operated mount and connection.

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ALUMINUM ENTRANCE AND STOREFRONT SYSTEMS

Scope

This section includes aluminum entrances and storefront. Aluminum windows installed in the storefront are covered in another section.

Use curtain wall framing instead of storefront for extensive exterior applications, particularly in areas where dimensions and configuration would require reinforcement. Typically, specify curtain wall for framing exceeding 12 feet in height.

Related Sections

U-M Design Guideline Sections:

[SID-D Energy Conservation](#)

[SID-F Codes and Regulatory Agencies](#)

[08520 Aluminum Windows](#)

[08710 Finish Hardware](#)

[08800 Glazing](#)

[08911 Glazed Aluminum Curtain Wall](#)

[Architectural Preferred Manufacturer List](#)

UM Master Specification Sections:

[08410 Aluminum Entrances and Storefronts](#)

[08520 Aluminum Windows](#)

[08800 Glazing](#)

[08911 Glazed Aluminum Curtain Wall](#)

Reference Documents:

ASHRAE 90.1-2007, "Energy Standard for Buildings Except Low-Rise Residential Buildings"

AAMA/WDMA/CSA 101/I.S.2/A440-2008: NAFS - North American Fenestration Standard/Specification for Windows, Doors, and Skylights

National Fenestration Rating Council (NFRC) Technical Documents

Design Requirements for Aluminum Entrances

Single source responsibility - Specify that all of the storefront components, including the glazing, windows and doors, be assigned to a single contractor. In addition, the storefront, windows and doors should be provided by the same manufacturer.

Construction - In general, manufacturer's standard products (with the exception of hardware) are acceptable, provided they comply with the following requirements:

- Storefront System Construction: Thermally broken.

- Door Opening Frames: Applied stops only; blade stops are not acceptable.
- Doors: Medium stile (3-1/2 inch nominal) or wide stile (5 inches or more) doors. Medium stile is preferred. Do not specify thin or narrow stile doors. Comply with current barrier-free code for bottom rail height.

Glazing - Specify glazing per design guideline 08800 and as follows:

- Exterior storefront and doors exposed to weather: Insulating glass to match window or curtain wall systems.
- Interior storefront and doors: Single pane glazing, unless insulating glass required for acoustic properties.
- Minimum glass thickness for single panes or individual components of insulating glass used in door and storefront systems should be 1/4 inch.
- Specify factory-glazed doors where feasible.
- Carefully coordinate the selection of glazing to achieve appropriate U-value and Solar Heat Gain Coefficient (SHGC) of the assembly. Specify total assembly U-values, not center-of-glass. [SID-D](#) requires designers to investigate the payback for improved U-values and SHGC.

Finish - Typically match window or curtain wall system finish.

- For most new and replacement work, specify 2-coat 70% polyvinylidene fluoride coating. Require 3-coat systems for organic coatings applied to doors.
- For anodized finishes, specify AAMA 611 Class 1 finish, clear or color anodized, as suited to project.

Hardware - Do not use door manufacturer's "standard" hardware for aluminum entrance doors. Comply with requirements of Guideline 08710 "Finish Hardware" and Preferred Manufacturer's List.

Other Considerations

Pay careful attention to specifying and detailing connections to adjacent construction, moisture control and the potential for incorporating enhanced thermal performance. Regardless of Delegated Design requirements (see below) for the storefront, the A/E is responsible for the interface between the storefront and the surrounding building (adjacent jamb, head and sill conditions). Perimeter flashing, sealants and insulation, continuity of the air barrier, anchoring and clearances must be thoroughly detailed at head, sill and jamb conditions.

In buildings with higher than typical humidity, perform a thermal analysis of the storefront assembly to ensure that condensation will be avoided on both the frame and the glazing. For buildings with typical humidity criteria it should be adequate to specify a minimum Condensation Resistance Factor (CRF) that takes into account the anticipated interior conditions. Refer to [Design Guideline section 15010](#) for typical mechanical design requirements.

Delegated Design

UM recognizes that it is common practice to specify structural performance criteria for curtain walls and to delegate the actual design needed to meet these criteria to the curtain wall manufacturer. Indicate the design loads and the displacement on the drawings. The A/E should utilize the Delegated Design language in contained in [AEC Masterspec Section 08410](#).

Testing

UM requires the storefront manufacturer to submit documentation of preconstruction testing showing that the designated system meets the performance criteria. If standard systems are being used the manufacturer is allowed to submit standard test reports for that system.

In-place field testing is also usually required for storefront installations. In special circumstances where the storefront is very limited in extent (especially if it is limited to entrance doors and framing), the requirement for in-place field testing may be waived by the Design Manager (DM). Obtain DM's approval in writing if field testing is to be waived. In most circumstances U-M will contract with a testing service for witnessing and validating testing, as well as for performing enhanced field inspections. The actual testing will normally be performed by the Contractor. In order to achieve testing of representative workmanship, samples for testing will be selected on a random basis by the A/E and the testing company (not the Contractor). At a minimum, field testing should be done twice; once fairly early in the installation process and again at the completion of the process.

Refer to language in [AEC Masterspec Section 08410](#) ("Manufacturer Testing" in Part 1 and "Field Quality Control" in Part 3) for appropriate language regarding testing.

DESIGN GUIDELINE 08520

ALUMINUM ARCHITECTURAL WINDOWS

Scope

Aluminum fixed and ventilating windows, including windows which are installed as part of a storefront or curtain wall system.

Related Sections

U-M Design Guideline Sections:

[SID-D - Energy and Water Conservation](#)

[08410 – Aluminum Entrance and Storefront Systems](#)

[08800 – Glazing](#)

[08911 – Glazed Aluminum Curtain Wall](#)

[Architectural Preferred Manufacturers List \(PML\)](#)

U-M Master Specification Sections:

[08410 – Aluminum Entrance and Storefront Systems](#)

[08520 – Aluminum Architectural Windows](#)

[08800 – Glazing](#)

[08911 – Glazed Aluminum Curtain Wall](#)

Reference Documents:

ASHRAE 90.1-2007, "Energy Standard for Buildings Except Low-Rise Residential Buildings"

AAMA/WDMA/CSA 101/I.S.2/A440-2008: NAFS - North American Fenestration Standard/Specification for Windows, Doors, and Skylights
National Fenestration Rating Council (NFRC) Technical Documents

General

Follow the guidelines below when specifying aluminum architectural windows and related items. Unless otherwise indicated, these guidelines are not intended to restrict or replace professional judgment.

Design Requirements

Standards: Comply with AAMA/WDMA/CSA 101.I.S.2/A440-08 specifications.

- Minimum performance class: Specify AW performance class windows for both fixed and ventilating units.
- Minimum performance grade: As required by calculated wind speed for location and exposure category.

Single Source Responsibility – Specify that windows, glazing and sealants be the sole responsibility of a single prime contractor regardless of the location within the specification. In addition, the windows should all be the provided by the same manufacturer.

Tests - Require submittal of test reports of a qualified independent laboratory indicating compliance with requirements. Review requirements for in-place field testing with Design Manager. Specify Owner's field testing for installations of more than 10 units.

Engineering:

- Indicate structural loads on drawings.
- Specify delegated design submittals, signed and sealed by an engineer registered in the State of Michigan.

Supplemental Performance Requirement: In addition to the requirements in SID-D and AAMA class AW, specify units tested to a minimum condensation resistance factor (CRF) based upon anticipated interior temperature and humidity conditions to ensure that there will be no condensation on the window surface.

Construction: Specify thermal-break construction without exception.

Glazing - Require glass surfaces to be located in the same plane, with a tolerance of 1/8 inch.

Carefully coordinate the selection of glazing to achieve appropriate U-value and Solar Heat Gain Coefficient (SHGC) of the assembly. Specify total assembly U-values, not center-of-glass. [SID-D](#) requires designers to investigate the payback for improved U-values and SHGC. Refer to Design Guideline 08800 for further requirements.

Finish - Comply with the following:

- For partial renovations and replacement projects, match existing adjacent units to the greatest extent possible.
- For most new and entire building replacement work, specify a 70% polyvinylidene fluoride coating. See PML for acceptable manufacturers.
- Color: In general, specify non-metallic dark bronze. Coordinate other color selections with Design Manager.
- Specify two-coat application technique; or three-coat for applicable colors/metallics.
- Siliconized polyester and similar coatings are not acceptable.
- When an anodized finish is judged appropriate, specify AAMA 611 Class 1 finish, clear or color anodized, as suited to project.

Requirements for Ventilators:

- General:
 - Specify ventilator units with full weather-stripping.
 - Specify insect screens for Housing projects and food preparation areas only.
- Office installations – UM standard practice is to provide a minimum of one ventilating unit per office. Review project requirements with Design Manager.
- Housing installations - Specify 6" sash limiters on all residential windows. Coordinate with Design Manager.

Warranty: Require a 10-year warranty on all components of window system.

Other Considerations

Pay careful attention to specifying and detailing connections to adjacent construction, moisture control and the potential for incorporating enhanced thermal performance. Regardless of Delegated Design requirements (see below) for the windows, the A/E is responsible for the interface between the windows and the surrounding building (adjacent jamb, head and sill conditions). Perimeter flashing, sealants and insulation, continuity of the air barrier, anchoring and clearances must be thoroughly detailed at head, sill and jamb conditions.

In buildings with higher than typical humidity, perform a thermal analysis of the windows to ensure that condensation will be avoided on both the frame and the glazing. For buildings with typical humidity criteria it should be adequate to specify a minimum Condensation Resistance Factor (CRF) that takes into account the anticipated interior conditions. Refer to [Design Guideline section 15010](#) for typical mechanical design requirements.

Delegated Design

UM recognizes that it is common practice to specify structural performance criteria for windows and to delegate the actual design needed to meet these criteria to the manufacturer. Indicate the design loads and the displacement on the drawings. The A/E should utilize the Delegated Design language in contained in [AEC Masterspec Section 08520](#).

Testing

UM requires the storefront manufacturer to submit documentation of preconstruction testing showing that the designated system meets the performance criteria. If standard systems are being used the manufacturer is allowed to submit standard test reports for that system.

In-place field testing is also usually required for window installations. In special circumstances where the extent of window work is very limited, the requirement for in-place field testing may be waived by the Design Manager (DM). Obtain DM's approval in writing if field testing is to be waived. In most circumstances U-M will contract with a testing service for witnessing and validating testing, as well as for performing enhanced field inspections. The actual testing will normally be performed by the Contractor. In order to achieve testing of representative workmanship, samples for testing will be selected on a random basis by the A/E and the testing company (not the Contractor). At a minimum, field testing should be done twice; once fairly early in the installation process and again at the completion of the process.

Refer to language in [AEC Masterspec Section 08520](#) ("Manufacturer Testing" in Part 1 and "Field Quality Control" in Part 3) for appropriate language regarding testing.

End of U-M DG 08520

FINISH HARDWARE

General

For University of Michigan Hospitals and Health Centers projects refer to Design Guideline 08710-H available at:

<http://www.med.umich.edu/facilities/planningdevelopment/ae/dg/doc/a/08720H.pdf>.

In general, follow the guidelines below when selecting and specifying finish hardware. Unless specifically indicated otherwise, these guidelines are not intended to restrict or replace professional judgment.

Related Sections

U-M Design Guideline Sections:

[SID-D Energy and Water Conservation](#)

[SID-F Codes and Regulatory Agencies](#)

[SID-Q Building Access Control](#)

[08410 Aluminum Entrances and Storefronts](#)

[Architectural Preferred Manufacturer List](#)

UM Master Specifications

[Section 08710 Finish Hardware](#)

[Section 16724 Security System General Requirements](#)

[Section 16727 Access Control & Monitoring System](#)

Design Requirements

General:

- Do not use cash allowance provisions for hardware.
- Include a hardware schedule on drawings or in specifications. Note key side on door schedule.
- Egress:
 - Do not specify locks of any type on fire egress stair doors without approval from Design Manager.
 - Configure doors and select hardware to mitigate the risk of chaining doors together, thus preventing egress and emergency responder access. (e.g. same handing of entrance door banks, flush mounted panic devices, etc...). Review approach with Design Manager.

- In areas of new construction, locate hardware in accordance with Door and Hardware Institute (DHI) "Recommended Locations for Architectural Hardware for Wood Flush Doors" and "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames." In renovated areas, obtain direction from Design Manager concerning whether to match existing hardware locations or whether to follow DHI recommendations for new construction.
- Do not specify floor checks and pivots.
- Trim Styles: Unless otherwise approved by the Design Manager, trim styles used in renovation work should match hardware currently in the building. Contact the Design Manager for information regarding existing hardware.
- Finishes: Unless otherwise approved by the Design Manager, comply with the following:
 - Specify standard uniform hardware finishes throughout the project. Obtain Design Manager approval for custom finishes.
 - For renovation work, match hardware finish of existing units.
 - For aluminum entrances, match the finish color of the door.
- Do not connect door hardware to fire alarm system unless required by code or UMHHC operating procedures.
- Where interconnection with building fire alarm system is required, comply with the following:
 - Provide interposing interlocks using fire alarm system control modules. Program the control modules to change state only when the fire alarm system actuates.
 - Fire door hold-open devices: Provide normal (non-battery backed) power from fire alarm system. Upon a fire alarm system actuation or upon the loss of normal power to the fire alarm system, the door hold-open devices will be de-energized and the doors will close. This means held-open doors will close during a fire alarm 24 hour battery test. Review operational impacts with Design Manager.
 - Electrically operated door hardware: Provide power from access control system or security system. When required by code, provide relay and access control system programming to interrupt power upon a fire alarm system actuation. This means the status of door hardware devices will remain unchanged during a fire alarm 24 hour battery test, but will change upon a fire alarm system actuation. The sequences of operation for door hardware devices upon fire alarm system actuation will be defined and executed by the door access control system.

Hinges:

- Specify hinges with non-removable pins with set screw, not merely non-rising type with knurled pin.
- Specify 5 knuckle ball bearing hinges, except at aluminum entrances or where otherwise needed for increased durability as confirmed by the Design Manager.
- For aluminum entrances, specify ball bearing butt hinges or heavy-duty continuous gear hinges.

Closers:

- Specify surface mounted units only; concealed closers are not permitted (including aluminum entrance doors).
- Require closers to be mounted on least public room side of doors.
- Never specify hold-open function in conjunction with exterior building entrances and vestibules.
- Provide factory-sized closers, adjustable to meet field conditions and barrier free requirements for opening force. Installation requirements shall require that closers be installed and adjusted to meet barrier free opening force requirements.

Pulls: Through-bolt all pulls. Do not specify offset pulls on doors unless needed to match existing.

Locksets:

- Specify lever handles on each new lockset.
- Specify the following standard functions by space type:
 - Offices, laboratories, small conference rooms and other non-classrooms occupied spaces: Office lockset with thumb turn inside (ANSI F04). Specify thumb turn installation that provides vertical orientation for locked / horizontal for unlocked.
 - Classrooms: All classrooms should be lockable from inside the room and provide visual indication of door status on classroom side. Review required function with Design Manager.
 - Mortise lockset type M1 (When locked, door remains locked except by key outside or thumb turn inside): Schlage L9056 with indicator: 09-611 x XL11-986.
 - Mortise lockset type M2 (When locked, door reverts to unlocked when door is opened): Schlage L9050 with indicator: 09-611 x XL11-986.

- Unisex restrooms: Privacy lockset with "Occupied" indicator and keyed override. Schlage L9496
- Service areas: Service/store lockset (ANSI F07)
- Provide knurled handle surfaces on doors to hazardous areas. Hazardous areas include mechanical rooms, elevator machine rooms, electrical closets and substation rooms, and stairways.
- Attic Stock: Require attic stock to be delivered to Owner's Key Office in manufacturer's original packaging, with Project title, including building and description, and University of Michigan Project Number marked on each box. Require attic stock for each individual lock function type, provide additional locksets of the same function in the following quantities:
 - For less than 20 locksets: No attic stock.
 - For 20 locksets or more, but less than 100 locksets: 2 additional units.
 - For 100 locksets or more: 4 additional units.
 - For each 50 additional locksets over 100 units: 1 additional unit.
 - When 20 or more locksets of all function types are scheduled, but less than 20 are of a single function, provide 2 additional locksets of functions selected by the Design Manager from the range of function types included in the Project.
- Strikes: Specify curved-lip strikes; flat (reversible) strikes are not acceptable. Require extended lip strikes where required to protect door frame from being marred by latch bolt (frequently needed at wood door frames).
- Cores: Specify 7-pin small format interchangeable cores (SFIC). Refer to "Architectural Preferred Manufacturers List" for manufacturers. In existing buildings, match existing core type.
- Construction Keying: For project security, provide a construction core as determined by the Design Manager. Always include construction cores for building entrance doors with cylinders.
- Keying: Include keying and master keying. Specify that keying and master keying will be coordinated with the University Key Office. Indicate keyed side on door schedule.

Panic Hardware: Either tube-or pad type crash bars are acceptable, provided the type selected will meet the requirements of the application. Dogging, where provided, should be hex-key wrench type as opposed to key cylinder type. Exit devices with concealed vertical rods are not permitted in any application. In addition, comply with the following:

- Single doors: Select rim-type panic hardware; do not specify mortise units.
- Double doors with mullions: Provide rim-type, center latching devices.
- Double doors without mullions: Provide the following exit device types for each indicated application:
 - Aluminum Entrance Doors: Applications without mullions are not permitted.
 - Fire-rated wood and steel doors: Usually specify mortise lock device with double cylinder on one door of pair (refer to "fire-rated and securable doors" paragraph below), and exit only function vertical rod device on other door. For interior locations where fire-rating can be maintained, omit bottom rods. Where bottom rod is required, specify ADA compliant rod and latch guard.
 - Non-fire-rated wood and steel doors: Usually specify mortise lock device on one door (refer to "fire-rated and securable doors" paragraph below), and exit only function vertical rod device on other door. Omit bottom rods for interior locations without security requirements. Where bottom rod is required, specify ADA compliant rod and latch guard.
- For fire-rated doors and securable, non-fire rated doors with rim and mortise type panic device applications (requiring an active lever handle), provide an exterior-side cylinder that retracts the latch bolt (but will not unlock outside trim) in conjunction with an interior-side, separately keyed cylinder, mounted in the latch head, that will unlock the outside trim.
- Specify pulls in conjunction with panic hardware, except where levers are required for fire-rated devices, or are necessary to match adjacent trim. Never select lever handles for use on public entrance doors to buildings.
 - Where lever trim must be provided to match existing non-fire-rated hardware in a given location, specify rigid lever function only.

Coordinators: At all double doors without mullions include a coordinator and carry bar. Doors with a mortise lock on the active door may have an open-back strike substituted for the coordinator and carry bar as permitted by rating authority.

Mullions: On double doors, where a fixed mullion is not included, provide a removable mullion. Key operated mullions are preferred. Where provision of a mullion is not considered feasible, provide special exit device hardware indicated above.

Thresholds: Require that aluminum thresholds be cut-in around mullions, frame members, and stops, not simply butted to them, to provide a continuous surface across the full width of the opening from jamb to jamb. At exterior doors, specify thermally broken thresholds.

Stabilizers: Require stabilizer sets on all aluminum entrance doors and frames.

Electrified Hardware (connected to campus central electronic system):

- General:
 - Do not specify magnetic locks or delayed egress devices without prior approval of the Design Manager.
 - Specify passive infrared request to exit devices in lieu of hardware with integral REX function. Coordinate with electrical.
- Hardware types / components:
 - Electric strikes: Specify where feasible. For pairs of doors with removable center mullions, specify wiring to electric strikes with quick disconnects. Do not specify for fire rated doors.
 - Electric mortise lockset: Specify for interior applications only.
 - Electric panic device with electric latch retraction:
 - Specify battery backed local power supply. For pairs of doors or doors in close proximity, provide single power supply serving both doors.
 - Specify label in end cap of exit device indicating location of power supply.
 - Electric power transfer: Provide heavy duty mortise type only. Electrified hinges and door cords are prohibited without prior approval of the Design Manager.
 - Door contacts: Specify 1" recessed door contacts where possible.

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GLAZING

General

In general, follow the guidelines below when specifying glazing and related items. Unless otherwise indicated, these guidelines are not intended to restrict or replace professional judgment.

Related Sections

U-M Design Guideline Sections:

[SID-D Energy and Water Conservation](#)

[SID-F Codes and Regulatory Agencies](#)

[08410 Aluminum Entrance and Storefront Systems](#)

[08525 Aluminum Architectural Windows](#)

[08911 Glazed Aluminum Curtain Wall](#)

[Architectural Preferred Manufacturer List](#)

UM Master Specifications:

[Section 08800 Glazing](#)

[Section 08805 Interior Glazing](#)

Standards

IGCC/IGMA Certification for Insulating Glass Seals

GANAL "Glazing Manual"

ASTM C 1036 Standard Specification for Flat Glass for annealed float glass

ASTM C 1048 Standard Specification for Heat-Treated Flat Glass—Kind HS, Kind FT

Coated and Uncoated Glass for heat-treated and coated glass

ASTM C1172 - 09 Standard Specification for Laminated Architectural Flat Glass

16 CFR 1201 Safety Standard for Architectural Glazing Materials for glass in hazardous locations

ASTM E2190 - 08 Standard Specification for Insulating Glass Unit Performance and Evaluation

ASTM E1300 - 09a Standard Practice for Determining Load Resistance of Glass in Buildings
Insulating Glass Certification Council (IGCC)

Design Requirements for Exterior Glazing

General

Specify 1-inch thick, low-e coated, argon gas filled insulating glass in all vertical vision glass panels. Where spandrel glass is used, do not specify units with insulation board adhered to inside surface. Where metal filler panels are used, specify 1-inch thick aluminum sandwich panels with rigid insulation core.

Provide insulating glass units (IG) certified by the Insulating Glass Certification Council (IGCC) and Insulating Glass Manufacturers Alliance (IGMA).

Determine whether heat strengthened glass is required due to the effects of differential shading, tinting of glass, size of units, or other conditions. Typically restrict fully tempered glass to hazardous locations.

Tint and Appearance

Most older University buildings, including those with recently retrofitted windows, have non-reflective, bronze tint outer panes paired with clear inner panes. The current standard is insulating units with clear outer and inner panes and solar control low-e coatings which are clear in color. The goal is to maximize visible light transmittance while minimizing solar heat gain. The use of other tints and reflective coatings is discouraged. Review aesthetic, performance and budget implications of glass selection with Design Manager.

In most retrofit projects in which current ceiling heights are lower than the window head heights, use a non-vision spandrel panel composed of a 1" insulating glass unit with an outboard lite matching the tint and coating of the outboard lites in the vision panels and an inboard lite of non-tinted patterned glass. Determine whether the patterned inboard lites require heat strengthening, since patterned units tend to be weaker than clear float glass.

Where bronze tint glass is specified, include bronze anodized spacers unless "warm-edge" spacers are specified. Consider other color coated spacers where appropriate and available.

For quality control purposes, include a restriction that each type of exterior glass must be supplied by a single manufacturer and fabricator.

Require the glazing contractor to submit an adequate number of samples to display the color range of the glass. Because of difficulties with color variation in clear low E glazing, the following language, which is more rigorous than ASTM C 1036 and ASTM C 1376, should be included in the Quality Assurance article of the glazing specification if this type of glazing is included in the Project:

"Sealed Insulating Glass Units: In addition to other requirements in this Section, comply with ASTM D 2244- 09b Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates. Obtain written acceptance by the Architect and the Owner's representative of permissible color tolerance between test specimen and reference and the procedure for calculating the color tolerance for each material and condition of use."

Thermal Performance

Vertical/Slope/Horizontal Glazing:

Thermal performance characteristics for all exterior glazing types should be evaluated and selected based on the requirements of SID-D, including ECM's.

Since the Energy Code requires that U-value and SHGC maximums be determined for the entire fenestration assembly (not center-of-glass values), U-value and SHGC should ordinarily be specified in the accompanying Div. 8 aluminum framing sections (“Aluminum Storefront”, “Aluminum Windows” and/or “Glazed Aluminum Curtain Wall”) rather than in the “Glazing” section. Wherever possible, however, utilize very high performance glazing (maximum U-value of 0.3 and maximum SHGC of 0.33)

Other performance criteria:

- Determine whether control of UV transmittance is required to minimize damage to furnishings, draperies and/or collections. Review with Design Manager.
- Determine whether controlling visual glare is a project requirement and if so, apply appropriate methods to achieve the desired performance.

Low-e Coating

For most vertical glazing apply low-e coating to the second surface of insulating glass units.

For sloped glazing applications apply low-e coating to the third surface of insulating glass units.

Fritted Glass

Use of fritted glass to improve performance and control glare, especially in skylights, sloped, and horizontal glazing, is acceptable

Fabrication and Installation

Specify pre-glazing wherever possible.

There is some evidence to suggest that wet-dry glazing systems tend to perform better over the long run than dry gasketed systems. However, not all manufacturers’ products will support a wet-dry system. Verify glazing details with manufacturers. If sealants are to be used, specify pre-construction testing for sealant compatibility and adhesion.

The Drawings and Specifications should include details and requirements for each glazing condition.

Require insulating glass products to be sealed with dual seal method.

Fire Rated Glazing

Since wire glass is not safety glazing, UM discourages its use for most applications. Use the appropriately labeled fire-rated glazing in doors and windows requiring a fire rating.

Special Warranties

Require special project warranty on insulating glass of 10 years.

Require special project warranty on coated glass of 10 years.

Require special project warranty on laminated glass and dual glazed gel-filled fire-rated units of 5 years.

DESIGN GUIDELINE 08911

GLAZED ALUMINUM CURTAIN WALL

Scope

This section includes exterior aluminum framing and glazing. Glazing materials and methods are specified in another section. Aluminum entrance doors and windows which may be installed in the curtain wall system are also covered in other sections.

Related Sections

U-M Design Guideline Sections:

[SID-D - Energy and Water Conservation](#)

[SID-F - Codes and Regulatory Agencies](#)

[08410 – Aluminum Entrances and Storefronts](#)

[08520 – Aluminum Windows](#)

[08800 - Glazing](#)

[15010 - Basic Mechanical Requirements](#)

U-M Master Specification Sections:

[08410 – Aluminum Entrances and Storefronts](#)

[08520 – Aluminum Windows](#)

[08800 – Glazing](#)

[08911 – Glazed Aluminum Curtain Wall](#)

Reference Documents:

ASHRAE 90.1-2007, "Energy Standard for Buildings Except Low-Rise Residential Buildings"

AAMA CW-DG1 "Aluminum Curtain Wall Design Guide Manual"

National Fenestration Rating Council (NFRC) Technical Documents

General

Use curtain wall for all significant window wall installations, including multi-story, vertical spans of greater than twelve feet and extended horizontal lengths.

Single source responsibility - Specify that all of the curtain wall components, including the glazing, windows and doors, be assigned to a single contractor. Further, the curtain wall, windows and doors should be provided by the same manufacturer.

Curtain Wall Requirements

The curtain wall design shall incorporate the following features:

- Pressure-equalized system for managing moisture.
- Compliance with the appropriate AAMA and NFRC standards (see "Reference Standards" article in [AEC Masterspec Section 08911](#))

Other Considerations

Pay careful attention to specifying and detailing connections to adjacent construction, moisture control and the potential for incorporating enhanced thermal performance. Regardless of Delegated Design requirements (see below) for the curtain wall system, the A/E is responsible for the interface between the curtain wall and the surrounding building (adjacent jamb, head and sill conditions). Perimeter flashing, sealants and insulation, continuity of the air barrier, anchoring and clearances must be thoroughly detailed at head, sill and jamb conditions.

Carefully coordinate the selection of glazing to achieve appropriate U-value and Solar Heat Gain Coefficient (SHGC) of the assembly. Specify total assembly U-values, not center-of-glass. [SID-D](#) requires designers to investigate the payback for improved U-values and SHGC.

In buildings with higher than typical humidity, perform a thermal analysis of the curtain wall assembly to ensure that condensation will be avoided on both the frame and the glazing. For buildings with typical humidity criteria it should be adequate to specify a minimum Condensation Resistance Factor (CRF) that takes into account the anticipated interior conditions. Refer to [Design Guideline section 15010](#) for typical mechanical design requirements.

Delegated Design

UM recognizes that it is common practice to specify structural performance criteria for curtain walls and to delegate the actual design needed to meet these criteria to the curtain wall manufacturer. Indicate the design loads and the displacement on the drawings. The A/E should utilize the Delegated Design language in contained in [AEC Masterspec Section 08911](#).

Finishes

The preferred finish for most curtain wall work is 2-coat 70% polyvinylidene fluoride paint. For metallic finishes and on doors specify a 3-coat system.

Anodized finishes may also be acceptable for some projects; review with the Design Manager. For anodized finishes specify AAMA 611 Class 1 finish, clear or color anodized, as suited to project.

Testing

UM requires the curtain wall manufacturer to submit documentation of preconstruction testing showing that the designated curtain wall system meets the performance criteria. If standard systems are being used the manufacturer is allowed to submit standard test reports for that system.

In-place field testing is also required for curtain wall installations. U-M will contract with a testing service for witnessing and validating testing, as well as for performing enhanced field inspections. The actual testing will normally be performed by the Contractor. In order to achieve testing of representative workmanship, samples for testing will be selected on a random basis by the A/E and the testing company (not the Contractor). At a minimum, field testing should be done twice; once fairly early in the installation process and again at the completion of the process.

Refer to language in [AEC Masterspec Section 08911](#) (“Manufacturer Testing” in Part 1 and “Field Quality Control” in Part 3) for appropriate language regarding testing.

End of U-M DG 08911



GYPSUM BOARD ASSEMBLIES

Scope

In general, follow the guidelines below when designing and specifying Gypsum Wallboard Assemblies and accessories.

Related Sections

U-M Design Guideline Section:

[079200 Joint Sealants](#)

[099100 Low Emitting Paint and Coating Products](#)

093000 Ceramic Tile and Waterproofing

Interior Finishes in Division 9

Application Review:

- Evaluate project application for materials cost vs. benefit.
 - Abuse resistant gypsum product is more expensive than standard gypsum board. If the standard gypsum is installed in 2 layers it is more expensive than a single layer of the abuse resistant gypsum.
 - Abuse resistant gypsum board shall be installed full height. The finish surface of abuse resistant is slightly different from standard drywall. This finish difference is noticeable in a finished partition.
 - Installing abuse resistant drywall full height, even above the ceiling, is beneficial versus having 2 different board types. It is more cost effective to install full height abuse resistant than to change to another material above the ceiling and risk the wrong product installed.

Design and Installation Requirements

Generally follow design practices outlined in manufacturer's literature and standard industry manuals.

Design non-loadbearing partitions in accordance with steel stud and drywall manufacturer's published recommendations regarding stud depth and gage for each application.

Incorporate steel or plywood sheet backing into gypsum board partitions where required to support equipment, panels, or furnishings, and as otherwise deemed necessary by the Design Manager.

Clearly mark fire-rated and smoke rated assemblies on drawings with either Underwriter' Laboratories or Gypsum Association design numbers, and with required fire rating in hours.

- Partitions shall be marked with UL designation above ceiling to prohibit unauthorized penetrations of mechanical items or conduits.

Design assemblies to provide sound control ratings established by the Project program or by the Design Manager.

Plastic trim is generally acceptable for interior applications, except specify metal trim at outside corners and other locations subject to impact damage.

Material Requirements

Gypsum General: Usually specify gypsum board for partition applications a minimum of 5/8-inch thick; and for suspended ceilings, soffits and fascias a minimum of 1/2-inch thick. Thinner units are acceptable where required for bending, compliance with UL or GA Design requirements, or other design requirements.

Abuse Resistant: Abuse Resistant materials are generally designed to withstand abrasion, which typically occurs when hard objects are dragged along or across a surface. Utilize Abuse Resistant gypsum board products in areas of expected high use and abuse. Material selection shall be evaluated based on type of abuse expected, penetration, indentation, scraping etc.

- Utilize in all high cart traffic corridors, residence floor areas and corridors.
 - Certainteed; Air Renew Extreme Abuse.
 - Georgia-Pacific Gypsum DensArmor Plus Abuse Resistant Interior Panel
 - Continental Building Products [Lafarge]; Protecta AR 100 Abuse Resistant Panels
 - National Gypsum Company; Hi-Abuse Brand XP Wallboard (XP= extra protection)
 - United States Gypsum Co.; Fiberrock Brand Abuse-Resistant Gypsum Panels.

Impact Resistance: Impact resistant materials are designed to withstand dents and punctures when directly struck with hard or heavy objects. Product resistant to surface indentation and penetration.

- Utilize in all public and common spaces, lab facilities and corridors.
 - Certainteed; "AirRenew Extreme Impact Gypsum Board"
 - Georgia-Pacific Gypsum; DensArmor Plus Impact Resistant Interior Panels.
 - Continental Building Products [Lafarge]; Protecta HIR 300 High Impact Resistant Panels.
 - National Gypsum Company' Hi-Impact Brand XP Wallboard
 - United States Gypsum Co.; Fiberrock VHI Brand Abuse-Resistant Gypsum Panels.

Glass Mat Faced: Utilize Glass Mat Faced in wet areas as wall tile backer (toilet or locker rooms with ceramic tile that do not include showers, no pool or sauna areas and not submerged in water). Product is not accepted as a finish product. Verify with each manufacturer if product can be utilized for tile backing.

- Design professional shall evaluate project specific application.
 - Certainteed; “Diamondback Tile Backer”
 - Georgia Pacific Gypsum Corp.; “Dens-Shield Tile Backer”
 - National Gypsum Company; “Gold Bond e2XP Tile Backer”
 - United States Gypsum Co.; “Fiberrock Aq-Tough Tile Backerboard”

Acoustical Gypsum Wall board: Provide gypsum wall board as part of an overall tested, certified system, including sealant, insulation and framing. Provide for specific program driven applications.

- National Gypsum Company; Soundbreak wallboard
- Certainteed; Silent FX
- Quiet Solutions; Quietrock 530

Cement Board: Utilize cement board for substrate in partitions for showers and toilet rooms directly adjacent to showers that are in high humidity areas to receive full height tile applications.

- Reference Ceramic Tile section for further information regarding cement board products, waterproofing and applications.

Flexible Gypsum Wallboard: Utilize at tight radiused applications.

- Georgia Pacific ToughRock FlexRoc Gypsum Board
- USG; Sheetrock Brand Flexible Gypsum Panels

Metal Stud Framing

Provide framing gauge as needed for partitions on a project specific basis.

- Provide studs with cut outs to accommodate conduit.
- Dimpled studs are acceptable provided they can accommodate deflection criteria established by design professional.

Metal Stud Framing Size Guidelines:

- Provide 3 5/8” minimum metal studs for interior office partitions and general spaces.
- Provide 4” minimum metal studs for interior partitions where there may be large conduit runs or as required by height requirements for partitions.
- Provide 6” minimum metal studs for interior partitions at locations with mechanical piping / plumbing located within the partitions.



CERAMIC TILE AND WATERPROOFING

Scope

Scope: Material selection, substrate selection, waterproofing choice, and installation.

Related Sections

U-M Design Guideline Technical Section:

[Section 092116 Gypsum Board Assemblies](#)

U-M Master Specification Sections:

[Section 092116 Gypsum Board Assemblies](#)

[Section 093000 Tiling](#)

Reference Documents:

TCNA “Tile Council of North America” for tile installation and guidelines.

Design and Installation Requirements

General – This document provides basic information for consideration by the design professional.

Material selection -

When selecting tile for installation consider the University use, long-term installation, cleanability and application. Special attention is necessary in areas such as food service, toilet rooms, showers, and serveries. In areas with a presence of water or grease evaluate appropriate slip resistance factor.

Tile Substrate Application –

- Cementitious Backer Unit – Backing and underlayment material that can be installed in wet or dry locations. Suitable for floor, wall and ceiling applications. Cement board is recommended in high moisture (not submerged in water) areas to receive full height ceramic tile.
 - Typically installed in community toilet rooms, housing toilet rooms, and shower rooms. Cement board is more expensive and durable than gypsum based products. Although cement board is more costly than gypsum board products it provides a higher performance as a tile substrate.
- Coated Glass Mat Water-Resistant Gypsum Backer Board – Backing substrate for wet and dry applications. Suitable for floor, wall and ceiling applications.

- Fiber-Cement Underlayments – A dispersed fiber-reinforced cement backer and underlayment that can be installed in wet or dry areas. Suitable for floor, wall and ceiling applications.
- Fiber Reinforced Water Resistant Gypsum Backer Board/ Underlayment – Backer board/ underlayment conforming to ASTM C1278, can be installed in wet or dry areas. Suitable for floor, wall and ceiling applications.

Waterproof membranes- Membranes may be single or multi component liquid applied or a sheet membrane.

- ANSI A118.10 Compliant
- Liquid applied is preferred in areas with multiple corners and drains for increased coverage and ease of installation.
- Utilize under tile in toilet rooms, laundry rooms, dining facilities, shower rooms, any area that is near a water source that could flood or over flow. Install in areas that receive frequent mopping and cleaning.
- In shower areas and areas to be frequently power washed install waterproofing full height behind tile.

Crack Isolation membranes- Install crack isolation membranes in areas of existing slab on grade or concrete on metal deck. Utilize in areas with existing cracks in slabs. Refer to manufacturer recommendations for size of cracks that can be accommodated. Membrane isolates tile from in-plane substrate cracking.

- ANSI A118.12

Installation Requirements

Water Testing – In areas of waterproofing installation a water test shall be performed at completion of waterproofing installation and again at completion of tile application. Drains shall be plugged and room flooded with minimum 2” of water for minimum 24 hours. If no leakage is evident from underside of slab or adjacent floor areas continue with next stage in construction. Note, water testing is required at every shower/ drain location.

Waterproofing installation at wall location – Waterproofing from floor application shall return up wall 6” and overlap wall waterproofing by minimum 4”.

In all cases where spillage or flooding is possible, caulk around all new and existing through-floor pipe and sleeve penetrations. Coordinate sealing requirements with mechanical engineer.

Specification Format

In specifications include a tile installation schedule to include the type of installation, tile, grout mortar and specific information for each type of tile. One source documentation that includes everything the contractor will need to bid, purchase and install each type of tile included within a project.

When specifying ceramic tile follow format below:

3. __ Interior Tile Installation Schedule

A. Type of installation (Interior Floor Installations, Concrete Subfloor, wall installation etc.):

1. (description: wall, floor, ceiling etc.) Tile Installation (insert TCNA # if applicable):
Description

- a. Tile Type: utilize same abbreviation as shown on finish schedule
- b. Thin-Set Mortar: type of mortar
- c. Grout: Type of Grout
- d. Other specific information about tile install, i.e., pattern, membrane installation etc.



ACOUSTICAL CEILINGS

Scope

For University of Michigan Hospitals and Health Centers projects refer to Design Guideline [095000-H: CEILINGS \(09510-H\)](#).

In general, follow the guidelines below when designing and specifying Acoustical Ceilings and accessories.

Related Sections

U-M Design Guideline Section:
[Codes and Regulatory Agencies](#)

U-M Master Specification Sections:
[220500 – Common Work Results for Mechanical](#)

Design and Installation Requirements

Submittals

For buildings subject to the jurisdiction of the State of Michigan Bureau of Fire Services (Instructional Spaces and Dormitory Spaces), include requirement for Affidavits of Compliance.

Design Requirements

In general, exposed grid suspended ceilings are preferred over concealed systems. Avoid spline and other non-accessible systems when any mechanical systems or equipment will be concealed above ceiling.

There are currently no standardized product types for acoustic panels. However, the following general guidelines apply:

- 2 foot by 2 foot panels are preferred over 2 foot by 4 foot panels.
- Rabbeted edge panels are preferred except where economy is paramount.
- 3/4 inch thick panels are preferred over 5/8 inch panels.
- Fiberglass panels are not acceptable.
- Where possible, specify humidity-tolerant acoustical panels carrying a minimum 10 year warranty.
- Specify gypsum board or other washable panels and moisture resistant grid in food service areas. Product shall be certified for intended use, ie. USDA for food service.

Where ceiling-mounted items obstruct the regular spacing of hanger wires, design "trapeze" structures with additional steel supports to bridge the obstruction.



CORK FLOORING

Scope

Applications and design considerations for cork flooring in University buildings.

References

South Coast Air Quality Management District (SCAQMD) Rule #1168, corresponding to an effective date of July 1, 2005 and rule amendment date of January 7, 2005.

Applications

Cork is comfortable, reduces noise, and can have sustainable properties. As a natural wood product, it is not suitable in all locations. Do not specify for locations with any of the following characteristics:

- Chemical exposure from occupant activities or cleaning requirements
- High sun exposure - cork will fade in direct sunlight
- Building entries with high foot traffic and salt / snow
- Potential for standing water
- Locations with high point loads

Design Requirements

Wear surface density: Minimum 30 lbs per cubic foot

Thickness: Engineered material of sufficient thickness to allow product to be sanded and refinished on a 3-5 year cycle. Expectation is floor can be sanded and refinished 2 or 3 times prior to replacement being required.

Finish: Specify the following:

- Raw cork for field finishing
- Multi-component high performance polyurethane coating - 3 coats minimum. Coating shall be recommended in writing by flooring manufacturer.
- Note that installer qualifications, substrate preparation, and dry times between coatings are critical for material performance.

Sustainability requirements

VOC content – Follow the requirements of SCAQMD Rule #1168 regarding VOC content of flooring adhesives and finishes.



RESILIENT FLOORING

Scope

Scope: Material selection, VOC content, installation, and cleaning of resilient flooring.

For University of Michigan Hospitals and Health Centers projects refer to Design Guideline 09650-H available at:

<http://www.med.umich.edu/facilities/planningdevelopment/ae/dg/doc/a/09650H.pdf>

Related Sections

UM Master Specifications:

[Section 096500 Resilient Flooring](#)

Reference Documents:

South Coast Air Quality Management District (SCAQMD) Rule #1168, corresponding to an effective date of July 1, 2005 and rule amendment date of January 7, 2005.

Design and Installation Requirements

General - Given the wide variety of flooring materials and applications throughout the University, there are no widely applicable standards for flooring selection. Consult the Design Manager for specific types of flooring to be used.

Demolition - In the event that existing resilient flooring or adhesive contains asbestos, consult the Design Manager.

Laboratories - Several campus units require use of sheet vinyl floors with heat welded seams and integral, coved base to contain spills in laboratories. Consult the Design Manager for specific types of flooring and installation standards to be used.

VOC content – Follow the requirements of SCAQMD Rule #1168 regarding VOC content of flooring adhesives. Avoid the use of chemical welding for sheet vinyl seams unless necessary for project, since the products used for this purpose tend to have very high VOC content. For LEED projects, use products complying with the FloorScore standard unless there are special requirements which necessitate the use of a noncompliant product.

Installation - In all cases where spillage or flooding is possible, caulk around all new and existing through-floor pipe and sleeve penetrations. Coordinate sealing requirements with mechanical engineer.

Cleaning - Specify that the contractor clean floors of construction debris, dirt and grease as a requirement of Substantial Completion. The contractor must not wax new flooring; the University will clean, seal and wax floors as necessary after acceptance.



LOW EMITTING PAINT AND COATING PRODUCTS

Scope

VOC content of paints, coatings and wood finishes products.

Related Sections

U-M Master Specification Sections:

[099100 – Painting](#)

Reference Documents:

Green Seal Standard GS-11, Paints, 1st Edition, May 20, 1993

Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997

South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004

Design Requirements

Follow the guidelines below when selecting and specifying paint products. Use low-VOC products complying with the referenced standards except when circumstances conform to the stated exceptions.

- For interior paints comply with Green Seal Standard GS-11, Paints, 1st Edition, May 20, 1993.
- For anti-corrosive coatings comply with Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997.
- For wood coatings comply with SCAQMD Rule 1113 in effect on January 1, 2004.

Exceptions: Obtain the written permission of the Design Manager for all exceptions.

- Animal rooms.
- Areas subject to standing water or extremely high humidity.
- Exterior paints and coatings.



SIGNAGE

Scope

For University of Michigan Hospitals and Health Centers projects refer to [Design Guideline 101400-H Signage](#).

In general, follow the guidelines below when designing and specifying signage and accessories.

Related Sections

U-M Design Guideline Section:

[SID-F – Codes and Regulatory Agencies](#)

[SID-H – Drawing and Construction Document Standards](#)

Reference Documents:

[Style Guide: Colors The Official University of Michigan Colors](#)

[Campus Wayfinding and Signage Guidelines](#)

[University of Michigan Emergency Preparedness](#)

Design and Installation Requirements

Exterior Building Signage

New construction is to include appropriate exterior signage in the form of free-standing UM standard blue and white building ID signs. Consult Design Manager for required quantity, locations and additional information regarding ID signs. All major renovations will also include the upgrade or replacement of existing building ID signs, as the condition of the existing sign(s) warrants. The design, wording, placement, materials, and installation details of exterior signage must be approved by the University Planner's Office.

Consult the Design Manager for information regarding permanent signs on buildings. The Planner's Office will provide policies and guidelines regarding allowable signage on exterior walls, doors and windows of buildings and the design, wording, number, placement and materials of such signage.

Each University facility shall identify its accessible building entrances with the international symbol for accessibility. Additionally, signage is required at inaccessible entrances to direct users to an accessible entrance or to a location at which they can obtain information about accessible facilities.

Signage Characteristics

Signage is to be provided per code requirements and as noted here. If there is a conflict between these requirements and code requirements, code requirements supersede. Permanent room numbers are to be indicated on room signs as both tactile and raised Braille characters. Indented characters are not to be used. Braille characters may be located within an incised area on the face of a sign.

For renovation projects, consult Design Manager for information regarding existing room signs and extent, type, and supplier of new room signs. Usually, where one or only a few new signs will be installed, new signs should match existing signs. However, in areas where only a few signs will be installed, designers should evaluate the feasibility of replacing old, non-compliant signs with new signs in the visibly contiguous area.

In addition to the above requirements, for large construction projects the materials and design of new signs are to be selected to be compatible with sign standards of the college or department which will manage the proposed facility.

Emergency Evacuation Maps

New construction and major renovation projects are required to include emergency evacuation maps as part of interior signage package. Consult Design Manager, who shall obtain standards from the Office of Emergency Preparedness.

Building Directories

New construction projects are encouraged to include building directories as part of interior signage package. Major renovation projects are also encouraged to upgrade existing and/or install new building directories. Consult Design Manager for guidelines and standards.

Room Number Assignments

Generally include room number signs for newly created or consolidated rooms and areas. In some cases, rooms to be remodeled and rooms within new additions cannot be assigned new numbers without renumbering rooms outside the project area. In these cases, provisions for new signage outside the project area should be included in the construction project.

Room numbers are assigned by the University's Manager for Space and Facilities Information in Architecture Engineering and Construction (AEC). Only University designated room numbers are to be indicated on construction drawings. Consult SID-H "Drawing and Construction Document Standards" and the Design Manager.

Laboratory Safety Signage

University standard laboratory safety signage is required at the entryway of each main research laboratory space where hazardous materials may be stored and used. Additionally, signage is required at special use inner rooms where hazardous materials exist, including but not limited to environmental, procedure, tissue culture, weighing, and pilot production. Safety signage is not required for dedicated waste storage/transfer rooms within large research buildings or animal holding/containment rooms which have a separate signage system developed specifically for the animal handlers. Review required locations with Design Manager.

Construction projects should include 8.5" x 11" clear acrylic holders (portrait orientation) outside of laboratories, typically located on the latch side of the door, below the room identification sign. Safety signage inserts will be provided by the academic unit, the facility management, or UM OSEH.

Some existing laboratories have 10" square safety signage. Renovation projects are required to replace old safety signage within the renovated area and are encouraged to replace old signage in the visibly contiguous area. Review with Design Manager.

TOILET COMPARTMENTS

Scope

In general, follow the guidelines below when designing and specifying toilet compartments. Unless specifically indicated otherwise, these guidelines are not intended to restrict or replace professional judgment.

Related Sections

U-M Design Guideline Section:

[102800 Toilet Accessories](#)

U-M Master Specification Sections:

[UM Preferred Manufacturers List](#)

Design and Installation Requirements

Generally, ceiling hung partitions are preferred for ease of cleaning. Coordinate ceiling hung units with supplemental structural steel support work. Steel support shall be designed by a structural engineer to resist rotational forces as well as weight concerns. Unbraced channels are not sufficient to stabilize panels.

Ceiling hung partitions are not recommended for ceiling heights in excess of 8'-0". Where ceiling suspended units are not feasible, provide floor supported units with headrail bracing at door openings. Wall and floor cantilevered units are generally not as stable and should be avoided.

Urinal screens shall be wall mounted to provide visual privacy and allow for ease of cleaning of floor below. Floor mounted option shall be reviewed with Design Manager.

Material Selection:

Provide Class A or Class B fire rated materials. Design Professional shall determine compliance of material required based on occupancy and use. Note Class A material is substantially higher cost and should only be specified if required by code. Otherwise provide Class B materials for cost saving and larger selection of product available.

Panel thickness shall be industry standard for material chosen.

- Painted Metal Panel: Constructed of galvanized steel with a high-grade synthetic enamel or powder coated finish.
 - Economical partition material.

- HDPE (High Density Polyethylene): Constructed from 1” thick high density polyethylene with homogenous color.
 - Preferred for housing and campus building projects
 - Mid-range partition material.
- Phenolic: Constructed of a solid phenolic core with a high-pressure decorative matte surface finish as an integral part of the core material.
 - Mid-range partition material.
- Stainless Steel: Constructed of minimum 20 gauge panels.
 - Premium partition material.

Hardware and Accessories:

- Provide stainless steel hardware with tamper resistant fasteners.
- Hinges: Either surface-mounted or cutout inset type, adjustable to hold door open at any angles up to 90 degrees.
- Latch and Keeper: Provide slide latch unit, with provision for emergency access.
- Barrier Free Latch and Keeper: At each out swinging partition door, in addition to standard hinges, coat hook and other specified hardware, provide manufacturer’s standard ADA-compliant latch and keeper. In addition, provide the following:
 - Handles: Provide manufacturer’s standard ADA-compliant pull handles on both the interior and exterior sides of partition doors.
 - Barrier-Free Latch and Keeper shall allow user to close and secure the door with a single motion of one hand.
- Coat Hook and Bumper: Mfr’s standard unit, rubber tipped.
- Purse Shelf: Stainless steel pull down purse shelves are desirable in women's toilet compartments.
- Door Pulls: Mfr’s standard, exterior of standard stall doors and both sides of barrier free stall doors.
- Brackets and fittings shall be stainless steel.



TOILET ACCESSORIES

Scope

For University of Michigan Hospitals and Health Centers projects refer to Design Guideline 10810-H available at:

<http://www.med.umich.edu/facilities/plan/vn/dg/doc/a/10810H.pdf>

In general, follow the guidelines below when designing and specifying Toilet Accessories.

Related Sections

U-M Design Guideline Section:

Section 102113 – Toilet Compartments

Product and Installation Requirements

Provide hand towel dispensers unless hand dryers requested instead by Design Manager.

Hand Towel Dispenser

The University provides hand towel dispensers for installation by the Contractor. The standard unit which is provided is a plastic body accommodating towel rolls. Units should be provided in sufficient quantity for the number of lavatories, but not less than 1 unit for each 3 lavatories. The Project Manager will arrange for delivery of the units to the job site in coordination with the Contractor.

Note: Units are 10" or greater in depth. Units shall be placed as required by code. Minimum of 1 unit per toilet room shall be placed to meet current ADA requirements.

- Roll Towel Dispenser Kimberly-Clark 09736
- Touch Free Dispenser Kimberly-Clark 09990
- Verify Specific Paper Dispenser with Design Manager.

Waste Receptacle

Avoid recessed or surface mounted stainless steel receptacles. Provide space for free-standing painted metal receptacles with vinyl bumper edge.

- Provide space for the waste receptacle near lavatories and adjacent to exit door. Locate outside of door operation clearances required by code.

Feminine Napkin/Tampon Dispensers

Specify stainless steel units dispensing both products. Recessed, semi-recessed or surface mounted types are acceptable. Units to be with 25 cent coin operation.

- Note a recessed model shall require a deeper partition stud depth.
- Mount so all operational and dispensing components are within required ADA reach range.

Liquid Soap Dispensers

Typically the University provides soap dispensers for installation by contractor. The standard unit which is provided is a plastic body unit with adhesive attachment. Position on wall adjacent to sink.

- If two lavatories are installed a single soap dispenser may be installed between the lavatories.
- Locate dispenser to be ADA compliant at ADA sink location.
- Verify specific soap dispenser with Design Manager.
- Soap Dispensor
 - Spartan #9756 White

Toilet Tissue Dispensers

The University provides toilet paper dispensers for installation by the Contractor. The standard unit which is provided is a plastic body unit for "jumbo" rolls. The University's Project Manager will arrange for delivery of the units to the job site in coordination with the Contractor.

- Architect of record responsible for placement of toilet tissue dispensers within ADA reach range.
- Verify Specific Paper Dispenser with Design Manager.
- Toilet tissue Dispenser Units – Kimberly Clark
 - 09551 for cored tissue – preferred style of paper
 - 09608 for coreless tissue

Feminine Napkin Disposal Units

Specify stainless steel units. Surface mounted units are acceptable; through-partition units are preferred. Unit shall be mounted in compliance with ADA guidelines.

- Exception in housing facilities. Due to population swing from year to year community toilet rooms servicing dormitory residents shall have free standing feminine napkin disposal units.

Grab Bars

- Concealed mounting anchors are desirable.
- Stainless steel 18 gauge minimum

- Provide non-slip texture.
- Outside Diameter 1 ½”.

Pull Down Shelves

Stainless steel pull down purse shelves are desirable in women's toilet compartments.

- Verify with users if shelves are preferred.

General Room Shelves

Provide at least one stainless steel shelf in each toilet room if no other provision has been made for setting down possessions.

- Verify with users if shelves are preferred.

Childcare Accessories

During the programming phase, determine whether diaper-changing stations are to be provided in toilet rooms and in which toilet rooms they are to be located. Regardless of whether changing stations are required for the project, in new construction and in renovations affecting toilet rooms, provide space for mounting a diaper-changing station in each toilet room, men's, women's and gender neutral. Reinforce the wall area at the changing station location adequately to support the changing station. Note proposed location of plans. Changing stations shall be fold-down type supporting a minimum of 250 lbs. of static load when opened and shall project no farther than 4" from the wall when closed.

Shower Accessories

Individual shower compartments shall be provided with the following list of accessories:

- Stainless Steel curtain rods
- Soap Dish, Assess need with end user and confirm with Design Manager.
- Provide fold up ADA compliant bench per grouping of showers, as required by code.
- Preference is to provide a separate private dressing area directly adjacent to shower.
 - Provide minimum 2 robe hooks in dressing area.
 - Provide a built in seat in dressing area.

FIRE EXTINGUISHERS

General

In general, follow the guidelines below when specifying fire extinguishers. Unless otherwise indicated, these guidelines are not intended to restrict or replace professional judgment.

Related Sections

Tab 15 - Mechanical ; Section 15300 Fire Protection

Design Requirements

Specify units with the following characteristics:

- Metal bodies, valve assemblies, discharge levers and carrying handles. Plastic or composite materials are not acceptable in these applications.
- Rubber hoses.
- Fully rechargeable.
- UL-listed, bearing UL "Listing Mark" for extinguisher type, rating, and classification.

Application

In addition to providing units in accordance with code requirements, provide a 4A:60BC, 10 pound (nominal) capacity unit in each individual laboratory. Mount units next to laboratory exit doors.

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LABORATORY FUME HOODS, BSC's, SPECIALTY HOODS AND ACID FLAMMABLE CABINETS

Scope

Laboratory chemical fume hoods, biological safety cabinets (BSC), HEPA filtered laminar flow clean benches, hybrid hoods, acid and solvent chemical storage cabinets.

Related Sections

U-M Design Guideline Section:

[123553 – Laboratory Casework](#)

[221113 – Piping Materials and Methods](#)

230920 – Lab Terminal Air Flow Units and Controls

U-M Master Specification Sections:

[115313 – Laboratory Fume Hoods, BSC's, Specialty Hoods and Acid Flammable Cabinets](#)

[123553 – Laboratory Casework](#)

[230920 – Lab Terminal Air Flow Units and Controls](#)

Design and Installation Requirements

General

Incorporate the requirements of this section taken together with the requirements of Design Guideline 230920, Lab Terminal Air Flow Units and Controls.

Use U-M Master Specification Section 11 5313 Laboratory Fume Hoods, BSC's, Specialty Hoods and Acid Flammable Cabinets as the basis for chemical fume hood specification on all U-M projects. Specification defines fume hood types in terms of face velocity characteristics. Use these definitions when specifying fume hoods and designing fume hood exhaust systems at U-M. Specification has been customized to include many of the Design Guideline requirements. For ease of identification, requirements identified in this document by **gray highlighting** are already incorporated in the specification. Note that the specification does not include BSCs or any specialty hoods (e.g. perchloric acid, hybrid hoods, etc.).

Edit U-M Master Specification Section 115313 to make it project specific. Extensive editor's notes are included in the specification to assist the A/E. Be sure to turn on hidden text and read those notes.

Fume Hood Design Requirements

Selection and Design

Selection:

- Select hoods in close consultation with the Project Mechanical Engineer, Design Manager and the University's Department of Occupational Safety and Environmental Health (U-M OSEH).
- Complete thorough programming effort with hood users and OSEH to determine the types of work being conducted in the fume hood, the experience of the users, the materials which will be used in the hoods, and any special requirements for the hoods.
- Consider impact on mechanical requirements.
- Select hood size and type to conserve energy. Specify the narrowest width which properly accommodates user needs. When selecting a hood type evaluate hood air volume usage in conjunction with required lab air change rates.
- Evaluate hood density. Densities above three hoods per 5000 net square feet of lab shall be justified. Consider alternatives such as snorkels and chemical storage cabinets.

Performance: Comply with the requirements of ASHRAE Standard 110-95 As Manufactured, and relevant portions of NFPA 45. U-M Master Specification Section 115313 describes the specific ASHRAE 110 performance criteria required for fume hoods used at U-M.

Location: Follow the general recommendations in the National Institutes of Health publication *Methodology for Optimization of Laboratory Hood Containment*. In addition:

- Locate hoods away from excessive traffic, cross drafts and air turbulence from windows, doors, or diffusers.
- Locate hoods such that fire, explosion or toxic material escaping the hood would not cross the immediate path of room egress.
- Perform computational fluid dynamics analysis when hood proximity or density may affect the successful operation of the hoods.

Types

Hood Types: Clearly delineate the hood types required for the project, either in the hood specification or on the drawings (preferred).

- Constant Volume: Partial bypass type are appropriate in most circumstances. Full bypass type are high energy users but may be appropriate in certain applications with U-M OSEH approval.

- Variable Air Volume (VAV) Hoods: Specify VAV hoods if energy analysis proves energy savings. Always specify VAV hoods for combination sashes. For all applications utilizing VAV hoods, specify the corresponding VAV type lab terminal air flow unit control.
- Reduced Face Velocity Hoods: RFV hoods, as defined at U-M, are those that U-M has approved to operate at a reduced average face velocity, currently 70 FPM. They are used to save energy while providing equivalent capture to a conventional hood. U-M has developed specific performance requirements for these type hoods, along with a list of approved RFV fume hood models/manufacturers. The following also applies to RFV hoods:
 - Do not vary from the approved list of manufacturers or models.
 - Do not modify the RFV hood performance criteria.
 - Maximum hood width: 6' nominal.
 - Maximum over-all hood depth: not to exceed 36".
 - Minimum ceiling height in room: 8.5'
 - Use only "bench-top" style hoods, not floor model, perchloric acid, or radioisotope hoods.
 - Balance to provide 70 FPM average face velocity and alarm at 60 FPM face velocity. Clearly indicate air balance information in the mechanical documents.
- Bench-top hood: Designed to rest atop a counter or base cabinet, usually about 36" above the finished floor. Consider accessibility requirements when specifying height and configuration.
- Floor model hood: Used where taller apparatus is required or equipment is to be rolled into the hood. Floor model hoods shall provide a minimum of 78" of working height.
- Radioisotope (RI) hood: Most low-level radioisotope work can be carried out in standard fume hoods. Therefore, if radioisotopes are to be used, consult with U-M OSEH to determine which type of hood to specify.

Sash Type

Clearly delineate the hood sash type for each fume hood, either in the hood specification or on the drawings (preferred).

- Vertical rising sash: Appropriate in most circumstances.
- Combination sash: Specify when justified by the type of hood use. Constant volume hoods of any type are not safe with combination sash arrangements because correct face velocity can't be assured as the horizontal sash is adjusted. Always specify with restricted bypass VAV hoods.

Sash Stops

Specify all fume hoods with integral sash stops. Add-on stops are not acceptable.

Height for sash stops: 14" from the work surface, with a minimum clear opening height of 12" above the airfoil. For airfoils of unconventional design, adjust the location of the sash stop to maintain the 12" clear opening height.

Equip all hoods with sash alarms.

Work Surfaces

Solid Cast Epoxy Resin: Typically specify solid cast epoxy resin tops.

Stainless Steel: Specify for specialty applications only, typically RI and perchloric acid hoods.

Linings

Specify linings to meet requirements of NFPA 45, paragraph 9-1.1 (flame spread less than 25). The following are possible choices:

- Fiberglass-Reinforced Polyester Resin Panels (FRP): Typically specify FRP. Note that FRP has limited chemical and heat resistance. Stainless Steel: Provides higher heat resistance than FRP but decreased chemical resistance. Specify only in RI hoods, perchloric acid hoods and when high heat resistance is required.
- Others: Other materials are available from some manufacturers, providing increased chemical resistance. Due to minimal thickness required by application, verify that alternate materials are properly reinforced against breakage during transport and use. Review material advantages and cost/benefit ratio compared with the typical choices listed above.

Baffles

- Fixed baffles: Specify for fume hoods in teaching labs or other locations where users may be unfamiliar with fume hood operation.
- Adjustable baffles: Typically specify for research laboratories.

Controls and Alarms

Chemical fume hood controls and alarms are specified in U-M Master Specification 23 0920 Laboratory Terminal Air Flow Units and Controls. Chemical fume hood controls, including low exhaust flow and sash alarms, are to be provided and installed by the laboratory air flow controls contractor under section 230920, not the fume hood manufacturer. The fume hood manufacturer provides cut-outs for the low exhaust air flow alarm and makes provisions to allow mounting of sash sensors, sash alarm, and other devices provided by the laboratory air flow controls contractor.

Mechanical Service Fittings

Mechanical service fittings for non-specialty fluids and gases (domestic water, compressed air, natural gas, etc.) used in chemical fume hoods are specified in U-M Master Specification Section 115313 Laboratory Fume Hoods, BSC's, Specialty Hoods and Acid Flammable Cabinets. Specify factory piped units whenever possible. Piping within the fume hood shall match materials in Division 22 Mechanical Specifications.

If RO or DI water service fixtures are required, edit 115313 to include a specification for these fixtures. Specify plastic materials (PP, PVDF, etc.) and a fixture design (dead-end or re-circulating) compatible with the purity requirements of the distribution system supplying the fixture.

If other specialty fluids or gases are required (e.g. medical gases), specify compatible fixtures and fabrication techniques. The related Division 22 mechanical specification should always be referenced in such cases.

Cupsinks may be either side-mounted or mounted in the work surface (with a raised rim), depending on user needs. Coordinate location of sinks mounted in the work surface with raised rims around the perimeter of the work surface.

Electrical

Specify ground fault circuit interrupter receptacles in fume hoods and within 6 feet of fume hoods which contain sinks.

Hoods require a circuit for the hood lighting and outlets and another, separate circuit if the hood is to be equipped with an air flow monitor or similar control. These separate circuits must be indicated on the electrical drawings.

Additional Superstructure Components

Consider the following components where appropriate:

- **Enclosure Panels:** Where the gap between suspended ceiling and top of fume hood will expose ductwork and equipment, consider specifying removable enclosure panels to conceal dead space and neaten appearance. However, rooms without suspended ceilings rarely benefit from enclosure panels.
- **Floor Model Hoods:** Specify either a stainless steel or epoxy resin floor constructed so as to retain spills, but tapered to facilitate ease of move-in for roll-in items.

Base Unit Design Requirements

Coordinate the specification of base cabinets with fume hoods for size, depth and finish match. Specify products from a single distributor to facilitate construction coordination.

Typically specify both a flammable/solvent and a corrosives storage base cabinet, each equal to half the length of the hood. Where standard cabinet lengths make this impossible, or where special storage requirements dictate additional storage capacity, locate supplemental storage units elsewhere in the laboratory. Do not locate supplemental flammable/solvent storage cabinets next to the hood superstructure. Specify either wood or metal:

Corrosives Storage Units: Specify units vented directly to the fume hood exhaust duct, not the hood exhaust chamber. Provide a detail on the architectural/lab planning and the mechanical drawings. Specify polyethylene lining with coved corners.

Flammable/Solvent Liquid Storage Units: Do not vent. If the client requests venting, review with Design Manager and U-M OSEH.

Review potential conflicts between flammable storage base cabinets and cupsinks. Not all manufacturers have resolved this conflict for their standard cupsink sizes and locations. Avoid placing cupsinks over flammable storage base cabinets. Non-standard placement or non-standard size of cupsinks may also cause problems.

Biological Safety Cabinets, Laminar Flow Clean Benches, Hybrid Hoods

Before specifying, verify with the Design Manager that they are to be included as part of the fixed construction. Select the type, size and class of these units in conjunction with the Design Manager and U-M OSEH representative.

If an exhaust connection is required to a Biological Safety Cabinets, verify with U-M OSEH the type required, direct or thimble connect. Connection are typically made via an indirect, hood mfg. provided, thimble (canopy) connection.

For BSCs, provide a minimum of 12" clearance on each side of the cabinet and between the top of cabinet and the ceiling, to allow service and testing. Provide an electrical outlet for the BSC power plug in a location that allows unplugging without moving the BSC (mount the outlet on a wall or casework to the left or right of the BSC or in the leg space below the BSC).

Performance and Testing: Fume Hoods/BSCs/Clean Benches/Hybrid Hoods

Laboratory chemical fume hoods:

- Typically specify to meet the As Manufactured (AM) ASHRAE 110 performance requirements found in U-M Master Specification 115313 Laboratory Fume Hoods, BSC's, Specialty Hoods and Acid Flammable Cabinets. Performance requirements for both standard (those operating at 100 fpm average face velocity) and RFV hoods are provided in 11 5313. These performance requirements may be inadequate for hoods which are to be used for extraordinary purposes, such as those involving highly toxic chemicals, high production volumes, or high-hazard radioactive materials. In such cases, the Design Manager and U-M OSEH shall provide direction regarding alternative AM or As Used (AU) testing.
- In some locations, additional As Installed (AI) testing may be required for a certain percentage of fume hoods. This is most likely to occur in new research buildings or areas with a high density of hoods. The Design Manager and U-M OSEH will provide direction regarding whether AI testing is required and, if so, the quantity and type to be tested. Indicate the hood quantities and types to be AI tested in the design documents.

Biological safety cabinets, laminar flow clean benches and hybrid hoods:

Provide performance criteria for within the specification sections. When a function of these devices is to provide *personnel protection*, performance requirements *for capture* should typically match U-M's 115313 performance requirements for standard chemical fume hoods.



WINDOW TREATMENT

Scope

Includes design and installation requirements for roller shades and horizontal venetian blinds.

Related Sections

U-M Design Guideline Section:

[Architectural Preferred Manufacturers List](#)
[SID-D Energy and Water Conservation](#)

Design and Installation Requirements

Design Requirements

General - A University-wide standard for window coverings does not exist. Window coverings are determined for each building individually, and are based on exterior and interior appearance, building use, environment, existing window coverings in adjacent areas, use and maintenance considerations.

Aesthetics - Base standards for new buildings on both exterior and interior appearance. When designing remodeling projects within an existing building, consider using the same type of window coverings as existing adjacent areas.

Environment - Consider requirements for protecting areas from the glare and heat of the sun. Also consider the environmental conditions in which the coverings will perform, such as exposure to chemicals, humidity, dirt or grease. Review flame retarding properties of window coverings for compliance with codes and condition of use.

Use – Public and student occupied areas need to withstand significant abuse.

Installations – Window treatments shall be installed in such a manor to allow full access to the window for cleaning, screen removal and window operation shall not be impaired.

Style of Window Treatments

Roller Shades – Roller shades should be considered for new construction or major renovation including new window treatments throughout the facility.

- Consult with user to establish openness factor, fabric style and color.
- Consider dual roller in meeting rooms, conference rooms or performance spaces that are on exterior of building. Dual roller option would allow for partial or full room darkening capabilities.
- Operation, consult with user to determine type of use and operation required. Determine Manual, motorized or automated with sensors.

- Manual, provide nickel plated metal bead style chain. Operation function shall stop and hold shade at any position in ascending or descending travel.
- Motorized: Motor location preferred within roller tube. Coordinate with manufacturer for maximized motor operation.
 - Connect as many shades as possible to maximize use of motor and minimize operators and cost.
 - Determine if operation is switched near motor, remote, or keyed for security purposes in student areas.
- Automated: Motorized operation monitored by solar type sensors may be considered.
 - Automated shades allow for the shades to be lowered as the solar gain increases within a space.
 - The sensors also bypass human interaction and may be more effective for managing heat gain.
 - Prior to proceeding with automated shades with sensors develop a cost analysis with a cost payback timeframe for utilities to be saved vs. the cost of the sensor system installed.
- Mounting Recessed: Recessed within a ceiling pocket permitting easy removal and replacement without damaging roller shade or adjacent surfaces and finishes.
- Mounting Surface Mounted: Surface mounted to face of partition above glazing or from ceiling or soffit area above glazing. Provide enclosure, for streamlined view and protection of roller from dirt, dust and debris.
- Direction of roll: Regular from back of roller
- Bottom Bar: metal bar or welded seaming.
- Size: Larger windows need larger shades that can be heavy. Evaluate splitting large sections of glazing into multiple shades. Larger heavy shades may be difficult to operate.

Horizontal Venetian Blinds - Typically specify heavy ladder, top slat and bottom rail construction, good quality of slat materials, and operating mechanisms that eliminate overdrive (preventing damage to worm gear or control wand). Private offices may use blinds fabricated of lighter weight material and without overdrive protection. Consult Design Manager.

- Venetian blinds may be utilized in renovation projects to match existing building standard horizontal blinds.

Maintenance –

The University Building Services Department can be requested to clean or repair blinds on a customer pay request basis. Building Services has the ability to clean standard horizontal blinds up to 10 feet in length. Preferred style for cleaning and maintenance is 1” aluminum mini blinds, preferably by Hunter Douglas. Consult with Design Manager and obtain departments' approval before specifying other types of window coverings. Select only those coverings with acceptable warranties.

Documentation-

Consider having installers visit site to assess mounting surfaces and existing conditions. A site visit can reveal potential issues as well as ensure accurate cost estimates up front.

Ensure notation for the following: Shades/ window treatments should be installed in a manner which will not inhibit operation of the window treatment or the window's function. It is the responsibility of the installer to verify function of the window as well as the window treatment as part of a standard installation.

Installation –

The University requires that a qualified dealer purchase and install blinds or shades composed of parts from the same manufacturer (single-source responsibility for both supplier and manufacturer) and labeled as to manufacturer and brand name.

End of Section.

LABORATORY CASEWORK

General

In general, follow the guidelines below when specifying laboratory casework, fixtures and related items. Unless otherwise indicated, these guidelines are not intended to restrict or replace professional judgment.

Consult with the University Project Coordinator for general layout and specific casework requirements.

Related Sections

Tab 11 Equipment; Section 11610 Laboratory Fume Hoods

University Preferred Manufacturers

Preferred manufacturers are listed in a separate document, "Architectural Preferred Manufacturers List." Obtain current copy from Project Coordinator.

Design Requirements

Casework

Types

Specify standard laboratory grade wood or metal casework.

- Consult with the University Project Coordinator regarding selection of wood or metal.
- When wood is selected, usually specify red oak veneer.
- Seal wood casework to prevent absorption of spilled materials.

Hardware

In newer buildings, and as otherwise possible, match existing handles and hinge styles. Usually specify manufacturers' standard units.

Finish

Manufacturer's standard finish is acceptable. Unless otherwise directed by the University Project Coordinator, include following requirements for wood casework:

- Sides which will be concealed in final assembly shall be of same species and finish as exposed surfaces.

- Bottoms of cases more than 48 inches above floor shall be of same species and finish as exposed surfaces.

Topset Cove Base Molding

Base can be specified in either casework or resilient flooring sections. If base is incorporated into resilient flooring specification, take the following precautions:

- Legshoes, if any, must still be provided by the casework manufacturer, since they are not a standard item for resilient flooring manufacturers.
- Where casework will be installed in areas that will not receive new flooring, check to ensure base required for casework is included in the scope of resilient flooring work.

Miscellaneous Fillers and Scribes

Show and specify fillers at gaps between individual cabinets, and between walls and cabinets. Include closure panels below all knee spaces to conceal pipe spaces. Fillers and scribes should match adjacent materials and finishes.

Countertops

The following materials are listed as guidance for selection. Select top materials with appropriate characteristics in consultation with University Project Coordinator.

- Epoxy Resin: Most commonly used material and generally preferred in most circumstances. Usually specify 1 inch thickness.
- Stainless Steel: Specify where seamless surfaces are required, such as processing areas for highly radioactive materials.
- Plastic Laminate: Generally, avoid plastic laminate in areas around sinks or otherwise subject to becoming wet. Chemically resistant laminates should be considered, but if chemical resistance is required, another top material may be better suited to intended use.
- Resin Impregnated Sandstone: These tops are as expensive, but less resistant to wear and chemicals than epoxy resin tops. Usually not specified.
- Man-Made Stone: Not acceptable for University projects.
- Methyl Methacrylate ("Corian"): Use care when specifying Corian to ensure chemicals used in laboratory will not stain or destroy the top. Corian is often specified when a white, chemically resistant top is required. However, Epoxyn makes a white epoxy resin top which could be considered. Seam sealants may also present a weakness, since silicone is generally used in lieu of the more chemically resistant epoxy sealants used with black tops.

- Solid Hardwood: Where desired by University Project Coordinator; of suitable construction, thickness and finish for intended purpose.

Shelves and Shelf Supports

Usually 45 pound density particle board with baked-on black acid resistant coating, smooth finished both sides with all edges radiused, and 1 inch thick (Kemshield or equal). In consultation with University Project Coordinator, select epoxy resin, solid hardwood, plastic laminate or other appropriate materials.

Typically, specify "Unistrut" standards and brackets spaced not more than 36 inches on center to prevent shelf sagging. Brackets and standards should be finished as follows:

Paint standards after erection, but prior to installation of brackets. Spray apply paint and allow to dry thoroughly before installing brackets.

Brackets should be painted with spray application methods and allowed to dry thoroughly before installation

Accessories

Sinks

Usually select epoxy resin sinks for lab installations. Select stainless steel sinks in consultation with University Project Coordinator for appropriate uses (such as integral top and sink installations, or in plastic laminate tops). Consider including stainless steel or PVC sink in laboratories where dry ice must be disposed (dry ice can cause epoxy resin to shatter).

Mechanical Service Fittings

Usually show and specify mechanical service fittings such as sinks, faucets, gas, vacuum and air outlets, and similar devices as part of Section 12345, for installation by plumbing trades.

Fittings for water, gas, air, vacuum and similar services should be brass, with at least 81 percent copper content.

Water fixtures should always be specified with integral vacuum breakers in every application. Integral vacuum breakers are available for almost all types of fittings, however, in the rare case where integral vacuum breakers are not available for a required fitting, provide in-line type units.

For distilled (purified) water faucets, specify PVC units with self-closing valves and integral PVC vacuum breakers. Do not specify plastic fittings in any use, except for deionized (purified) water outlets. For deionized water consider chrome plated brass faucet with polypropylene lining.

Electrical Service Fittings

Usually show and specify electrical service fittings such as pedestal outlets, and outlets and switches on fume hoods as part of Section 12345, for installation by electrical trade.

Receptacles: Receptacles supplied with electrical fixtures included in this Section shall be 125 volt, 20 amp, 2 pole, 3 wire, specification grade, extra heavy duty grounding type with nylon or Lexan bodies. Provide ground fault circuit interrupter receptacles within 6 feet of fume hoods and sinks. GFCI receptacles shall be rated for 2000 amps interrupting capacity and trip in 25 milliseconds or less when ground currents exceed 5 milliamps.

Switches: Switches supplied with electrical fixtures included in this Section shall be 120/277 volt, 20 amp, specification grade, extra heavy duty type.

Coordinate electrical locations of electrical outlets, wiremold and similar electrical items with casework layout.

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CONTROLLED ENVIRONMENT ROOMS

Scope

In general, follow the guidelines below when specifying package environmental rooms and related items. Several aspects of environmental rooms require close coordination with work of other sections. Among these are:

- Casework and shelving.
- Structural steel.
- Mechanical utilities.
- Electrical utilities.

Clearly indicate in specifications and on drawings all mechanical and electrical work which is required within the controlled environment room and which is required for connection to building utilities. Make sure that the equipment specification contains language that this work must conform to the requirements of Division 21, 22, 23 and 26 specification sections.

Include in the Specifications a requirement for submitting an Installation Manual (with the other project submittals) and an Operations and Maintenance Manual (prior to project completion).

Environmental rooms should be included in the list of equipment requiring commissioning in the project.

It is the Architect/Engineer's responsibility to obtain from the client and the Design Manager a complete understanding of how the environmental room(s) will be utilized and occupied and the required operating conditions (including special requirements such as the need for backup power and cooling). Backup power and cooling should not be provided routinely. It should be reserved for critical operations.

Related Sections

U-M Design Guideline Section:

[SID-F – Code Requirements](#)

Design and Installation Requirements

General

No University-wide standards exist for interior and exterior panel materials or finishes. Most commonly, painted aluminum exteriors are specified with either painted aluminum or stainless steel interiors.

Size unit to suit user requirements and available area. Specify height requirements as well as length and width. Manufacturers have unique standard sizes, so close tolerances will need

special coordination during design. In general, avoid specifying units with less than 7.5 feet interior height (approximately 8 feet outside dimension).

Provide necessary wall reinforcement for shelving, countertops, equipment and any other wall-mounted items.

The door hardware must include a break-away type latch (with cylinder lock if needed) and inside safety release handle so that the door can be opened from the inside even if it is locked.

Provide slip-resistant flooring.

Provide adequate access, clear of any interference from other building elements, to the condensing unit and any other equipment mounted exterior to the unit. This access must incorporate a reasonable means of getting from the floor to the top of the unit (for example room for a ladder from the floor to the above-ceiling space). In most circumstances, access through a 2 x 2 ceiling grid will not be considered adequate unless portions of the grid can be easily dismantled to allow for a larger opening. Include a fluorescent light fixture, power receptacle, and switch mounted in the ceiling space to provide illumination and power for servicing at top of unit. Clearly delineate the required access on the drawings.

Consider enclosure panels around the top of units which do not meet suspended ceiling height. Panels may need to be vented and removable to accommodate roof-mounted equipment.

For environmental rooms that will be used for crystallization, provide the following special features:

- Remote mounted compressor/condenser units (not mounted on roof of environmental room).
- Self-closing and sealing doors.
- Quiet relays and switches.
- Refrigeration system piping, blower, dessicant wheel (if any) and other vibration sources mounted on vibration isolators, and not along environmental room walls.

For environmental rooms that will be used to house animals, provide quiet switches and relays.

Operating Requirements

Specifications should include information regarding at least the following criteria. :

- Operating temperature range.
- Control range (+/-0.2 deg. C is usually acceptable).
- Uniformity range (+/- 0.5 deg. C is usually acceptable).
- Estimated door openings per hour (usually not less than 8).
- Number of occupants (maximum at any time).

- Heating load in watts of operating equipment (scientific apparatus, etc.) within room. If this load cannot be determined during design, assume heat load will equal 50 percent of outlet power capacity.
- Humidity range if applicable. Do not specify range if special humidity control is not required.
- Ambient conditions of the space in which the room will sit. Identify the maximum adverse condition likely to be encountered.
- Temperature range of process chilled water, if a water-cooled condenser is being used.
- Temperature and humidity range of makeup air (see Mechanical Design Requirements below) being supplied to the environmental room.

Furnishings and Equipment

Manufacturers

Some casework is available from representatives of environmental rooms. To date, no casework from these sources has been approved for laboratory use. Usually use equipment of approved laboratory furniture manufacturers for use inside controlled environment rooms.

Casework Materials

Use metal casework in controlled environment rooms.

Shelving Source

Shelving is available through the suppliers of environmental rooms, and is a recommended source of shelving if no casework from another source is to be provided in the environmental room.

Design

If casework is to be provided in the environmental room, usually treat the design as a standard lab project.

Structural Steel

Structural steel support frame may be required if remote mounted condensing units are selected. For example, support frames will usually be required when mounting units on building roofs, and when condenser is to be located within the laboratory area, but not on the roof of the environmental room (occasionally necessary, due to overhead space limitations).

Mechanical Design Requirements

Coordinate utility installation, and ensure mechanical design takes into account the following:

- Makeup air to the environmental room: Provide makeup air if the room is to be occupied (rather than just used for storage of materials and samples). Follow Code requirements for ventilation. For other circumstances, the A/E must establish whether

ventilation is required or advantageous. In general, if there is not a specifically identified need for ventilation, UM recommends not providing it, since makeup air may introduce unwanted humidity in environmental rooms. If makeup air is provided, exhaust or relief must also be provided. Provide ducted exhaust connections (hard pipe or thimble connection as required) to meet the requirements for both environmental room exhaust and/or dessicant dryer exhaust. Do not allow exhaust to be discharged from the environmental room into the ceiling plenum.

- Heat from condensing coil must be rejected to building exterior or a cooling loop.
- Water-cooled units should normally be specified. Do not specify air-cooled units which reject heat into occupied space or suspended ceiling plenum. Water-cooled units using city water as the primary cooling fluid are not permitted. However, if continuous operation of the environmental room is critical, consideration must be given to backup cooling which might include City water.
- Provide accessible filters for the evaporator coil.
- Utility piping may be factory installed and concealed in environmental room walls, or may be surface mounted in the field. Either method is acceptable, as long as appropriate coordination of factory and field work requirements is provided. Note that crystallization rooms require piping mounted on vibration isolators.
- Pipe penetrations through environmental room walls must be coordinated with room supplier. Room suppliers may, or may not, want to make the penetrations themselves. Mechanical specifications should call for coordination; leave final decision of who makes the penetration to the Contractor. Penetrations must be sleeved and sealed.
- A drain line must be shown from the evaporator unit drip pan to a safe waste (one containing an air gap). In freezer rooms, the drain line from the evaporator unit drip pan should be routed outside of the room. Coordinate location and consider installing floor drain to accommodate drain line.
- Humidification: The A/E must evaluate the most cost-effective method for providing humidification for the environmental room. If house steam can be made available cost-effectively at the room location, it should be used for humidification. If a steam generator is specified, the water quality for the steam generator must be coordinated with the manufacturer's requirements. Some manufacturers may require treated water of certain resistivity. If this is not available in the building, it may be necessary to provide additional treatment as an option for the steam generator.
- Dehumidification: The A/E should determine the most appropriate and economical method of dehumidification based upon the operating requirements and the type of equipment available from manufacturers. If a dessicant-type dryer is utilized, exhaust must be provided. See additional information regarding exhaust covered previously in this section.

Electrical Design Requirements

Coordinate utility installation, and ensure electrical design takes into account the following:

- Electrical panel and control panel must be provided by room manufacturer
- Electrical outlets and conduits may be factory installed and concealed in environmental room walls, or may be surface mounted in the field. Either method is

acceptable (although concealed conduits are preferred), as long as appropriate coordination of factory and field work requirements is provided.

- Conduit penetrations through environmental room walls must be coordinated with room supplier. Room suppliers may, or may not, want to make the penetrations themselves. Electrical specifications should call for coordination; leave final decision of who makes the penetration to the Contractor. Penetrations must be sleeved and sealed.
- Refer to Specification Section 262000 for information regarding the electrical panel.
 1. The panel should feed not only the loads within the room, but also the evaporator unit, compressor unit, control panels and any other equipment associated with the operation of the environmental room.
 2. If possible, locate the electrical panel next to the control panel. Do not locate it on the roof, or remotely from the controlled environment room.
 3. The electrical panel may be incorporated into the control panel, if this is the standard for the manufacturer. If this is allowed, the panel buses shall be braced for the available fault current, and the breakers rated to interrupt the available fault current of the distribution system. The panel shall also be UL listed for the application.

Coordinate connection of refrigeration unit, room controls and recorder, lights and outlets that are specified in Division 26.

- Lighting should be fluorescent (except incandescent for rooms with less than 0° F.).
- Specify UL labeled, vapor-tight light fixtures equipped with two lamps. Refer to Design Guideline Section 265100, and Specification Section 265100 for information on the lamps and ballasts. Provide electronic ballasts where suitable for application.
- Refer to Master Specification Section 26 2726 for specification information for light switches.
- Provide a minimum of 3 receptacle circuits to the receptacle inside the unit. Refer to Specification Section 132100 and 262726 for specification information on receptacles. Provide ground fault circuit interrupter receptacles within 6 feet of sinks or other water sources. Receptacle circuits shall be 20 ampere rated, and each circuit shall serve no more than 3 duplex receptacles. Adjacent receptacles shall be fed from different circuits.
- Provide a 1" raceway path for any 'data outlet' installed inside the environmental room.
- Data outlets shall be two gang, deep, boxes unless installed in surface raceway. See also Section 272000.
- The controller should be digital and electronic. It should be programmed to maintain the environmental room within the operating criteria. Battery backup of the controller should be considered in critical applications to maintain temperature logs during power outages or other disruptions. Controller shall be located near access door and maintained in clear view on exterior of unit.

- Recorders: Review with the Design Manager whether the manufacturer's standard chart will be adequate. Recorders for humidity-controlled rooms must include humidity as well as temperature readings.
- Alarms: Ascertain user requirements for both local and remote alarms. For remote alarms, consult with the Design Manager to determine whether alarms will be directly monitored by BAS (Building Automation System), which is typical for University Buildings, or to the Department of Public Safety (via MOSCAD) in special circumstances. At a minimum, provide the following alarms:
 - Common alarm for setpoint deviation or system trouble of temperature, humidity, etc.
 - CO₂ set point deviation alarm and automatic CO₂ safety alarm (for elevated CO₂ rooms only).



CONVEYING SYSTEMS – GENERAL REQUIREMENTS

Scope

This section defines general requirements for various conveying systems. Refer to individual Division 14 sections for additional requirements.

Consult with the U-M Design Manager for project specific requirements.

Related Sections

SID-F – [Codes and Regulatory Agencies](#)

SBA-E – [Parking Structures](#)

U-M Master Specification Sections:

142123 – [Electric Traction Passenger Elevator](#)

142423 – [Hydraulic Passenger Elevator](#)

144200 – [Wheelchair Lift](#)

146000 – [Hoists and Cranes](#)

Design and Installation Requirements

Preferred Manufacturers and Sub-Contractors

Refer to individual Division 14 Specification Sections.

Operation and Maintenance

On the Ann Arbor Campus, all conveying systems discussed in this section (except as noted) are operated and maintained by the Plant Operations Elevator Shop (734-647-2059) which can be contacted for specific maintenance records, for inspection information or access, and for renovation or replacement recommendations. Most general fund buildings are maintained directly by the Elevator Shop. The elevators at the U-M Hospital are covered under a maintenance contract with an outside contractor, with limited oversight by the Elevator Shop.

The Elevator Shop shall be consulted during the design of all conveying systems, and should assist with review of shop drawing submittals, and O&M manuals for conveying systems.

Inspection and Licensing Requirements

Most conveying systems in the State of Michigan discussed in this section are inspected and certified by the State of Michigan. Refer to SID-F Codes and Regulatory Agencies.

Elevators -

Definition

Passenger/service elevators with horizontally sliding door typically for general use of all types, including cars, entrances, controls, safety equipment, and elevator machinery.

Freight Elevators include vertically sliding bi-parting doors with automatic power operation used for transporting food and other equipment.

Application

Passenger elevators are preferred over freight elevators in almost all cases, including "service" applications, where users expect to be moving trash, equipment and materials in the elevator on a regular basis.

Requirements of Regulatory Agencies

Perform all work in accordance with applicable codes, the State of Michigan Elevator Code, the National Electrical Code, and the American Society Mechanical Engineering Code for Elevators, ASME A-17.1 (latest edition accepted by State of Michigan). All tests shall be made in the presence of the authorized representative of such authorities and the Owner's representative.

Comply with U-M Barrier free Elevator Guidelines attached herewith.

Design and Construction Method

The delivery method for elevators specifies installation of specific non-proprietary components with which the University has a successful track record. Installation is done by a pre-qualified **elevator installation contractor**. Installation of "elevator manufacturer's standard" elevator is not acceptable. Refer to Master Specification Sections 142123 and 142423.

Non Proprietary

The non proprietary delivery method shall be evaluated by the design team. A non proprietary elevator allows for maintenance to be done by the elevator shop or an authorized elevator repairman. The components do not require specific manufacturer knowledge or tools for repair. Non proprietary elevator applications may have a higher purchase and installation cost. This higher installation cost may be offset by lower long term maintenance costs.

Proprietary

The proprietary delivery method shall be evaluated by design team. A proprietary elevator is limiting in that only the manufacturer may service the installed elevator and may require special knowledge for repair. Typically a proprietary elevator is purchased with an ongoing maintenance plan for a specific term. Service by the Elevator Shop is limited. Consideration should be given to lifecycle cost for installation. A smaller up front purchase and installation cost may be outweighed by the long term maintenance contract requirements. Business units considering this application may consider the impact to their annual maintenance budgets versus original construction costs.

Selection of Type of Equipment

Building end use shall determine elevator type traction or hydraulic. Design Professional to evaluate and provide documentation to support decision. Choice shall be included in BOD and OPR documentation,

For Rise Up To 45 Feet: Select hydraulic or traction type elevator machine. Specify a dry pumping unit. That is, the pump, motor and valves should not be located in the hydraulic reservoir. (Note: Piston stabilizers not allowed)

For Rise Above 45 Feet: Select electric traction elevator machines.

Elevator Speed

Electric Traction Elevators Passenger/Service

- Minimum: 200 ft/min.,
- Maximum: 350 ft/min.

Electric Traction Elevator Freight

- Minimum: 200 ft/min.
- Maximum: 350 ft/min.

Hydraulic Passenger

- Minimum: 100 ft/min.
- Maximum: 150 ft/min

Roped Hydraulic

- Minimum: 100 ft/min.
- Maximum: 150 ft/min.

Hydraulic Freight

- Minimum: 100 ft/min.
- Maximum: 150 ft/min.

ElevatorControl/Controller

For both hydraulic and electric traction elevators: Specify non-proprietary microprocessor controls. Specify remote diagnostics shall be compatible with existing U-M system.

Elevator Type: Traction vs. Hydraulic

Hydraulic elevators are often less expensive than electric traction elevators, and don't require an elevator machine room above the hoistway, and are therefore often preferred by AEs.

However, there are limitations and drawbacks to their application. Traction elevators should be installed in lieu of hydraulic elevators where any of the following apply:

- Where total travel exceeds 45 feet.
- High volume applications, where speed of travel is a high priority

Elevator shaft, lobby and machine room location considerations:

Location: Coordinate with the Architect for location in the building for optimum service for the building. elevators should be near stairs

Security: Provide access control at building doors, not with card readers at the elevator landings or in the elevator cars. For security, locate the elevator within the building's access controlled area.

Access to mechanical rooms/ penthouse: Provide access to mechanical rooms/penthouse or basement via a controlled lobby with stair access and a locked keyed to mechanical room in penthouse or in the basement.

Roof access and lighting: Provide a safe access and path from roof access to the elevator machine room.

Elevators Air Lock: An air lock or transition chamber for controlling air pressure during ingress and egress from a multistory building (10) the interior of which is at an elevated air pressure.

Machine Room

Machine Rooms: Elevator machine room may be located overhead, basement or adjacent to hoistway for traditional traction or hydraulic. For machine room less (MRL) it shall be located at the top of the hoistway. The electric driving machine shall be located in a machine space within the elevator hoistway (MRL) or outside the hoistway in an elevator machine room.

Control spaces, and Control rooms: A controller shall be accessible only from a machine room, control room.

Machine/Control Room Lighting: Fluorescent lighting with guard shall be provided in the elevator machine room. Lighting shall be positioned so it does not create shadows while service personnel are working on major equipment. Minimum of 19 foot candles measured at floor level at any point in the machine room.

Fire Extinguisher: appropriate classification shall be 15 pounds for a fire extinguisher. Mount on the wall of elevator machine room near main entrance.

Machine/Control Room Door: Appropriately fire rated labeled self closing, self locking door.

Machine Room/Control Rooms Door Hardware: Keyed to U-M BEST "ZV" key system.

Elevator Machine Room/Control Rooms Painting: Paint elevator machine room floor with light gray gloss oil based paint. Paint elevator machine room walls and ceiling with white semi-gloss latex paint.

Elevator Machine Equipment: Paint elevator machine light gray with zinc primer paint

Hoist beam: In the elevator machine room above the machine. Size shall be suitable for largest live load.

HVAC: Machine rooms for traction and hydraulic elevators require HVAC systems to maintain temperature between 50F and 95F. System must be capable of operating 24/7/365. Size system for full load (building skin and internal loads, including oil cooler for hydraulic elevators). Ductless split system is generally preferred.

Vents: Many existing, older traction machine rooms include a floor vent that communicates directly with the hoistway. Where found, remove vents and provide 2-hour rated separation in its place.

Area of vents: The area of vents shall not be less than 3.5% of the area of the hoistway nor less than 3 square feet. Control damper with heat sensing.

Pressurization: The elevator machine room serving a pressurized elevator hoistway shall be pressurized upon activation of heat or smoke detector located in the elevator machine.

Plumbing and Mechanical systems: Pipes or ducts conveying gases, vapors or liquid and not used in connection with elevator operation shall not be used in the elevator machine room or hoistway.

Elevator Machine Room Access/Machinery Space: An approved means of access shall be provided to elevator machine rooms and overhead machinery spaces. Access to machine rooms shall not be through restrooms, locker room or associated vestibules. Direct access from a public corridor is strongly encouraged.

Isolation Transformer: Provide isolation transformer per elevator controller manufacturer's recommendation.

Machine Room Less Elevators (MRL)

Control Room Location: The control room shall comply with the code and manufacturer requirements.

Communication: Two-way visual communication shall be installed between the car and the control room. Car position, movement, location and direction shall be monitored from the control room.

Other equipment: No other equipment is allowed in control room.

Signage: A permanent sign shall be placed on the door that will read "MRL ELEVATOR CONTROL ROOM". The letter size shall a minimum of 3/4 " and shall be of contrasting color with that of the background.

Main Floor Signage: A permanent sign shall be mounted on the head jamb of the main floors entrance which shall read "MRL-CONTROL ROOM LOCATED ON _ FLOOR". The letter size shall a minimum of 3/4 " and shall be of contrasting color with that of the background

Working Clearance: A working clearance of at least 3'-6" shall be maintained in front of the elevator controller at all times with the control room door closed.

Disconnect Switch: A heavy duty disconnect switch shall be installed in the control room and in the hoistway within sight of the elevator driving machine and shall be designed so that it can be locked out and tagged out in the open position. When activated, it shall cause power to be removed from the driving machine and brake. It shall also be designed to open a contact in the stop position switch circuit and render the elevator inoperative.

Other Control Room Disconnect Switch and Receptacle: See electrical requirements.

Ventilation: The control room and hoistway must be vented for control of hot smoke and gases. If ventilation is accomplished by means of a horizontal duct, the duct shall have the same rating as the hoistway. Venting may be required by the building code additional make-up air may be required. Design Professional shall evaluate.

HVAC: The control room and hoistway shall be required to maintain at neither a temperature of not less than 55 deg. F. nor more than 90 deg. F. and with manufacturers requirements either by natural air circulation or by an HVAC system.

Hydraulic Elevator Cylinder Unit

Pumping Unit: Pumping unit shall be dry and have the valve and motor located outside reservoir. The unit must be mounted on isolation pads.

Hydraulic Oil Line Access: Provide clear access for hydraulic oil line between machine room and hoistway. No underground piping.

Hydraulic Oil Lines: shall remain in conditioned space from end to end and remain within the building footprint. No buried or counseled lines are allowed.

PVC Pipe: Comply with master hydraulic elevator specs

Cylinder: Comply with master hydraulic master specs.

Cylinder Exterior: Comply with master hydraulic master specs.

Other Hydraulic Elevators

Roped: The car is supported by steel hoist ropes and sheaves, which are moved up and down by a holeless single section piston in a cylinder.

Holeless: The car is connected on each side with a single section position that moves up and down in a cylinder, which mounted on top of the pit floor.

Hoistway

Shaft Enclosures: Comply with SID-F shaft enclosures shall have a fire-resistance of not less than 2 hours where connecting four stories or more and not less than 1 hour where connecting less than four stories. The number of stories connected by the shaft enclosure shall include any basement.

Hoistway Entrance: entrance shall consist of flush hollow metal door panels, bolted unit type frames, sills.

Sills: sills shall be of extruded aluminum or nickel silver construction with non-slip wearing surface. Supported on steel brackets and securely fastened to the floor. If cast sill is in acceptable condition re-use.

Class of Loading for Elevator: Class C1, C2 and C3 loading shall be for sill and platform for all type of elevators.

Shaft Paint: Painting shall include approximately 80% wall coverage with one coat of white paint. Painting required in Housing Building, Parking Structure and Medical School Building. Painting is not required in general fund buildings.

Shaft Lighting: single tube continuous fluorescent light fixture strip (full height of hoistway) with guard. Provide minimum one fixture per floor. Design Professional shall evaluate use of LED in lieu of fluorescent fixtures. This lighting shall be operable from a switch located in the elevator machine room, pit area and at the top floor. Shaft Lighting required in Housing Buildings, Parking Structures and Medical School Buildings. Shaft lighting is not required in general fund buildings.

Hoistway ventilation: Hoistway venting is required per code. Venting of hoistways is not required where the building is equipped throughout with an approved automatic sprinkler system.

Location of Vents: Vents shall be located below the floor at the top of the hoistway and shall open directly to the outer air or through noncombustible ducts to the outer air with back draft damper.

Piping in Hoistway: No piping, duct, electrical conduit, or other materials, etc. for non-elevator related equipment shall be allowed.

Exterior Hoistway: Provide automatically controlled heat in hoistways to provide minimum temperature of 50F, accounting for building envelope losses and infiltration at doors. Finned tube radiation is generally preferred with traps and shut-off valves shall be provided in accessible locations outside the hoistway or use listed/certified electric heaters with disconnect switch for each unit heater.

Pit Area

Construction at bottom of hoistway: Pits extending in the ground shall have noncombustible floors and be designed as to prevent entry of ground water into the pit. The pit floor of any hoistway not extending to the ground shall be of the fire resistive construction having fire-resistance rating at least equal to the required hoistway and have no habitable area under pit.

Pit Lighting: Lighting in pit area shall be a minimum of 10 ft candle measured at any point in the pit area at floor level.

Sump Pumps

- Provide sump pumps in compliance with the Michigan Elevator Code per ASME A-17.1 (latest edition accepted by State of Michigan) and Michigan Plumbing Code.
- Subsoil drains shall not be connected or discharged to elevator pits or sumps.
- Specify a simplex submersible sump pump for each hoistway with a minimum capacity of 3000 gallons per hour.
- Multiple hoistways may be served by a common sump pump sized to remove 3000 GPH per hoistway.
- Provide a union, a check valve, and an isolation valve on the pump discharge.
- Pumps ≤ 1 HP should normally be 120 VAC single phase.
- Pumps > 1 HP should normally be 208 VAC three phase.
- Pump voltages greater than 300 VAC are not permitted by code.
- The pump power cord shall be plugged into a non-GFCI power receptacle located in the hoistway. This arrangement shall serve as the pump disconnecting means in the hoistway. Power to this receptacle shall be controlled by the pump controller to cycle the pump on and off. The receptacle and cord cap shall be protected by a weatherproof cover.
- For *new hoistways* indicate that, at the contractors option, the sump may be either (1) cast-in-place and water-proofed with the same sealer used to water-proof the hoistway floor, or (2) a fiberglass sump. In either case, a sump cover shall be provided.
- For *existing hoistways*, the design should typically include a fiberglass sump with cover.
- Pumps shall be controlled by dual non-mercury float switches consisting of a “normal” level float switch and a “high level” float switch. “Oil Smart” or similar level controls shall not be used. The pump controller shall include a dry alarm contact for monitoring by the Owner’s Building Automation System (BAS). This contact shall energize under two conditions: any time the pump runs and any time high level is detected.

- For elevator hoistways where ground water intrusion into the sump is expected and thus the pump is expected to run frequently, only the high level float shall alarm at BAS (Building Automated System).
- Pump power cord shall not be run in conduit. Float switch, oil level detector cords (where oil separators are used) and any other control wiring shall be run in PVC conduit properly secured to the hoistway wall and floor. Conduit shall be connected to the sump cover and the conduit's inner diameter shall be sealed with sealing putty.
- Pump control panels and oil separators shall not be installed in hoistways or elevator machine rooms.
- Pumps Serving Traction Elevators:
 - Pumps shall discharge to a sanitary drain via an indirect connection.
 - Status lights (pump running, high level) and alarm annunciators associated with pump operation **shall not** be provided. Control panel **shall not** include a pump “on-off” or “hand-off-auto” switch on the panel face.
 - Typical Sequence of Operation for Pump (modify to make project specific): The Pump shall be cycled by the “normal” float switch to maintain normal fluid level in the pit. If high fluid level is detected by the “high level” float, the pump shall start (if not already running). The pump controller shall include a common dry alarm contact (non-latching) for monitoring by the Owner’s Building Automation System. This contact shall energize whenever the pump runs and when high level is detected
- Pumps Serving Hydraulic Elevators:
 - Pumps shall discharge to an oil separator. Oil separator shall discharge to a sanitary drain via an indirect connection. Size the oil separator to contain 110% of the volume of the largest elevator hydraulic circuit.
 - Status lights (pump running, high level) and alarm annunciators *associated with pump operation* **shall not** be provided. Control panel **shall not** include a pump or oil detection system “on-off” or “hand-off-auto” switch on the panel face.
 - Specify controls to monitor “half full” and “full” oil level conditions in the oil separator. Specify an annunciator, silence button, indicator lights, and BAS contacts to provide the sequence of operation indicated below.
 - Typical Sequence of Operation for Pump (modify to make project specific):

The pump shall be cycled by the normal float switch to maintain “normal” fluid level in the pit. If high fluid level is detected by the “high level” float, the pump shall start (if not already running). The pump controller shall include a common dry alarm contact (non-latching) for monitoring by the Owner’s Building Automation System. This contact shall energize whenever the pump runs and when high level is detected.
 - Typical Sequence of Operation for Oil Separator Level Alarms:

When the oil sensor detects a “half full” oil condition, it shall energize the Half Full indicator light, the common annunciator, and the Half Full BAS alarm

contact. Pushing the alarm silence button shall silence the alarm but the indicator light and BAS contact shall remain energized until the oil level drops below half filled.

When the oil sensor detects a "full" oil condition, it shall energize the Full indicator light, the common annunciator (even if previously silenced), and the Full BAS alarm contact. Pushing the alarm silence button shall silence the alarm but the indicator light and BAS contact shall remain energized until the oil level drops below the full level.

Pit Painting: Paint pit floor and walls (up to sill) with two coats of light gray, gloss, and oil based paint. Paint all exposed metal in hoistway (except Guide-rails) with light gray paints two coats of rust inhibitive paint.

Electrical Receptacles: (1) GFCI duplex at 48" A.F.F., and (1) non-GFCI duplex (for sump pump) receptacle at 24" A.F.F.

Access Ladder: Galvanized steel ladder to be mounted to floor and wall shall have skid resistant rungs.

Elevator Car Enclosure:

Car Lighting: Indirect fluorescent or LED coved lighting minimum of 10 foot candle in car at floor level install fixture equally on both side of elevator cab to balance the light. Lighting shall be easy to access to replace. Downlights or drop ceiling are not acceptable.

Emergency Lighting: provide emergency lighting with a battery unit in compliance with code requirements.

Car Dimension: Based on requirements of ADA Guideline and square footage floor requirements for landing per Michigan Code and ASME A17.1 Elevator Code.

Car Door: Flush hollow stainless steel panel's with sound deadening insulation.

Car Ceiling: Canopy ceiling shall be provided, painted white. Drop ceiling systems are not acceptable.

Car Flooring: Finished floor shall be heavy duty "Rubber tile sheet type vinyl" all shall be class "A" securely connected in place "commercial grade carpeting tile" or heavy duty tile or ¼" thick (minimum) checkered aluminum with matte finish. Materials such as stone or ceramic tile flooring add significant weight to the elevator car increasing equipment sizing and wear over time on equipment. Stone and ceramic tile flooring materials are strongly discouraged. Coordinate flooring material selection with end user and design manger.

Pads and Pad Hooks-Locks: provide pads and pad hooks with locks on walls near top 12" O.C provide educate size and storage cabinet.

Electrical Receptacle in Car: GFCI type duplex electrical receptacle in car approximately 2" above finished floor below car operating panel.

Ceiling Height in Elevator Car: Minimum of 8'-0" car heights.

Elevator Lobby

Hallway Position Indicator: LED (Light Emitting Diode) digital type and good for minimum of 5-years as part of hallway push button.

Hallway Push Button: Vandal resistant illuminated LED type hall push button shall be installed at each floor, fixture shall have up and down buttons at intermediate floors and single buttons at top and bottom floors, buttons shall be vandal resistant stainless steel with integral arrows and shall illuminate to indicate a call has been registered. Button shall remain illuminated until the call has been answered.

Hoistway Access: Hoistway Access features operable from top and bottom landings mounted on door jamb.

Lobby Lighting: 10 foot candle measured 1 foot from the sill at floor level. Feed the lighting with emergency generator power if the elevator can operate on generator power, or provide emergency egress lighting if the elevator cannot operate on generator power.

Landing System

Landing System: The landing system shall provide high speed stepping signals, one-floor-run stepping signals, leveling, and door zone signals. Shall be compatible with controller manufacturer.

Leveling: The leveling and stopping accuracy of the system shall be within 1/4 inch of the floor level and shall correct for over travel or under travel to within the same accuracy, regardless of load variations or direction of travel.

Electrical Requirements

Disconnect Switch location: Locate all disconnecting means for all elevator(s) on the inside surface of the machine room wall next to the strike jam side of the machine room door. Ensure each disconnect is within sight of the elevator equipment it controls.

Main Disconnect Switch: Provide a 3 pole fused elevator power disconnect switch. Switch shall be lockable in the open position.

Lighting Disconnect Switch: Provide a 2 pole, 240 volt, 30 amp fused elevator car lighting disconnect switch. Switch shall be lockable in the open position and contain 20 amp fuses. Feed the switch with a 20 amp emergency power circuit if generator power is available, or normal power if generator power is not available.

Car Receptacle and Fan Disconnect Switch: Provide a 2 pole, 120 volt, 30 amp fused elevator car receptacle and fan disconnect switch. Switch shall be lockable in the open position and contain 20 amp fuses. Feed the switch with a 20 amp standby power circuit

if the elevator can operate on generator power, or normal power if the elevator cannot operate on generator power.

Elevator HVAC: Elevator HVAC unit shall have a dedicated branch circuit with disconnect switch inside the machine room. Feed the switch with standby power if the elevator can operate on generator power, or normal power if the elevator cannot operate on generator power.

Receptacles: Provide 120V GFCI receptacles in each machine room within 6'-0" from the governor location, elevator controller and machine. In the pit area GFCI and non GFCI shall be provided.

Machine Room Light: Machine room light fixtures shall produce a minimum of 19fc at floor level and have lamps protected by wire guards. Light switch shall be located at the point of entry on the lock-jamb side of the access door. Feed the lighting with emergency generator power if the elevator can operate on generator power, or provide emergency egress lighting if the elevator cannot operate on generator power.

Pit Lighting: Locate light with wire guard more than just below (with clearance) the fully compressed buffer. Locate light switch on wall inside the hoistway adjacent to the top of the pit ladder. Feed the lighting with emergency generator power if the elevator can operate on generator power, or provide emergency egress lighting if the elevator cannot operate on generator power.

Isolation Transformer: Individual isolation transformers and individual choke reactors for each hoist motor (controller), and filtering of harmonic distortion when Variable Voltage Variable Frequency (VVVF) AC controllers are utilized.

Electrical Ground Wiring: Ground wire shall be the same size as feeder per Controller Manufacturer requirements.

Emergency Power Operation

Emergency power: Coordinate the need of emergency power with the activity use and project architect. Emergency power is usually needed for high-rise facilities as defined by code.

Standby Power: In building or structure where standby power is required.

Emergency Power Operation: when emergency power is detected, cars shall return to the main lobby one elevator at a time, and remain there with doors open. While each car is being returned, the other cars shall be shut down so as not to overload the emergency power generator.

One or More Cars: Once all car(s) have been returned to the lobby, one or more cars may be selected to run under emergency power, depending on the capability of the emergency power generator. Selection of the cars that run under emergency power shall be done by the group system. Or If more than one elevator is provided determine with activity input how many elevators are to operate on emergency power

Automatic Selection: the automatic selection may be overridden through manual selection. The actual number of cars allowed to run under emergency power shall be a pre-programmed value and the number of cars allowed to run shall not exceed this value

Disconnecting Means and Panel Location: Must disconnect the elevator from normal lockable power and from emergency power. Automatic transfer switch and disconnect shall be located outside the machine room. The panel for the manual selection switches for each group of elevator will be installed at a location determined by the university.

Override Switch: Manual override switch shall be provided in the main elevator lobby area(s) to override the automatic emergency power selection.

Manual transfer: Standby power shall be manually transferable to all elevators in each bank.

Mechanical Equipment: Where emergency power is connected to elevators, the elevator machine room ventilation, air conditioning equipment and hoistway ventilations shall be connected to the standby power source.

Fire Suppression

Machine Room Sprinkler: In elevator machine room's automatic sprinklers of ordinary or intermediate temperature rating shall be provided with guard. Sprinkler head shall not be installed over any elevator equipment. Provide a supervised shut-off valve with flow tamper switch in the sprinkler line supplying the pit. Locate the valve outside of and adjacent to the elevator machine room.

Pit Area Sprinkler: Sidewall sprinkler(s) with sprinkler guards in the pit area. Locate the sprinkler no more than 2'-0" above the floor. Provide a supervised shut-off valve in the sprinkler line supplying the pit. Locate the valve outside of and adjacent to the pit.

Hoistway Sprinkler: Provide a sprinkler(s) at the top of the hoistway for hydraulic elevators with cylinder or supply piping extending above second finished floor elevation. Provide a supervised shut-off valve, flow tamper switch. These items shall be located outside of and adjacent to the elevator hoistway.

Signage: Provide signage on valve outside of elevator machine room and pit area and shall read "Sprinkler Shut-off Valve for elevator ----"

Test Valve: Provide inspector test connection per code requirements.

Fire Alarms

Fire Alarms Devices: Only visible alarm notification shall be provided in elevator machine rooms.

Fireman Phone Jack: Provide a phone jack in the car as part of COP (Car Operating Panel) for fireman phone jack for high rise building phone jack is required in the elevator machine room.

Fire Alarm: A fire alarm initiating device shall be in the control space and tied in to elevator's fire emergency services.

Smoke Detectors: Stand-alone smoke detectors system shall be installed by elevator contractor

Speakers/Horns For Mass Notification: Speakers shall be mounted in car with a adjustable volume control that shall be adjustable at the elevator car top. Horns shall not be installed inside the car, hoistway or in the elevator machine room.

Hoists and Cranes - Section 146000

Definition

Manual and motor.

Application

Because of the infrequency with which these systems are installed, the University has no established guidelines for these systems. Furthermore, operation and maintenance may not be handled by the Elevator Shop. Consult Project Coordinator.

WHEELCHAIR LIFTS

General

In general, follow the guidelines below when designing Wheelchair Lift installations. Unless specifically indicated otherwise, these guidelines are not intended to restrict or replace professional judgment. These guidelines are applicable to permanent wheelchair lift installations.

Initial Determination of Suitability

In existing structures, wheelchair lifts should be provided as a means of achieving an accessible route only after all other options have been thoroughly considered and rejected. Wheelchair lift installations are difficult to successfully design and construct, and once built are prone to failure and subject to abuse by unauthorized users. The University does not permit the use of wheelchair lifts to meet accessibility requirements in new structures.

Code-Recognized Applications: Michigan Barrier Free Rules limit the use of wheelchair lifts to the following applications:

- To provide an accessible route to a performing area in an assembly occupancy.
- To comply with wheelchair viewing position line-of-sight and dispersion requirements.
- To provide access to incidental areas, not open to the general public, that are occupied by not more than 5 persons.

Exceptions to these recognized applications may be sought when existing structures make other alternatives impracticable. Inform the University Project Coordinator when an exception will be required.

Applicability To Site: Wheelchair lifts are limited by Michigan Elevator and Barrier Free laws and rules to the following:

- Total Rise: Not more than 72-inches (12 feet has been proposed by the Elevator Board).
- Number of Stops: Not more than 2.
- Through-Floor Penetrations: Not permitted.

Vertical Wheelchair Lifts

Lift Type: Generally, the University prefers vertical lifts over incline lifts.

Aesthetics: While full architectural hoistways for lifts are not required, give attention to appropriate placement of the unit and consider including screen walls or other architectural effects.

Approach: The approach path to the lift must be accessible, including the areas in front of both doors. Lifting device under-structures cause the platforms to be elevated about 3-inches above the finish floor level. Wherever practicable, depress the slab beneath the units to permit them to be accessed without a ramp at the lower landing. Where a depressed slab cannot be provided and a ramp is needed, the ramp must meet all relevant Michigan Barrier Free Rules and ADA/UFAS requirements, including those for landings at doors.

Hoistway, General: Hoistways may be either site-built architectural hoistways or manufacturer's standard hoistways that meet Michigan Barrier Free and Elevator Rules. Hoistways are required to be solid, with the lift-side smooth. If the hoistway is full height to the ceiling, a light must be provided in the hoistway, along with a sprinkler head in buildings with automatic fire suppression. Lights and sprinkler heads must comply with University standards for these devices, including provision of sprinkler head shut-off valve. Lights must be fed from a night-light circuit. Additional requirements include:

- Minimum Hoistway Height (Upper Landing): 42 inches above the upper landing.
- Minimum Hoistway Height (Bottom Landing): Total rise plus 42 inches.
- Shaft Clearance At Platform Sides: 2 inches minimum.
3 inches maximum.
- Shaft Clearance At Platform Ends: 3/8-inch min. running clearance.
3/4-inch max. running clearance.
3-inches max. at door.

Site-Built Architectural Hoistways: Drawbacks of site-built architectural hoistways include the coordination and code compliance problems associated with custom construction. Site-built hoistways include full or partial height doors on openings into the shaft. Highlights of code requirements and related University requirements for shaft door openings include:

- Doors must be swinging type and of solid construction. Lights in doors are permitted and the University encourages their inclusion.
- Doors must be self-closing, which may be accomplished by spring-hinges on partial height doors. On full height doors, the University encourages the inclusion of power-assisted operators. Where standard closers are included on full height doors, specify delayed-action type units.
- Door width should not be wider than the platform plus sidewalls. 36 inches is acceptable.
- The University requires push/pull type hardware.
- No hazardous protrusions are permitted. Special attention may be necessary regarding the interlock device.

Manufactured Hoistways: Manufactured hoistways have the benefit of single-source responsibility for operation and code compliance. The requirements for door openings of manufactured units are the same as those for site-built hoistways, but since manufactured units are supplied with their own

doors, the level of specification detail required is lower. Usually, inclusion of requirements to comply with the Michigan Elevator Rules is sufficient. The following is a list of University-required options for manufactured units:

- Doors must be self-closing, swinging type. The University requires doors to operate quietly. Specify some combination of sound-deadened door construction, door silencers, and hydraulic closers (as opposed to spring hinges), as necessary. Power-assisted operators are not required on light-weight doors. Lights in doors are permitted and the University encourages their inclusion.
- The University requires push/pull type hardware.
- If provided, hoistways around the tower (lifting mechanism) must be designed for easy removal for access to machinery.

Lifting Devices: The lifting device consists of a platform with guards, a lifting mechanism on one side of the platform, and various electrical devices. Platform size, gate and guardrail configuration and height, control locations and type, safety devices, and other features are regulated by the Michigan Elevator Rules. Some of the lifting devices shown in manufacturer's literature do NOT comply with the Michigan Elevator Rules, even though they may comply with ANSI requirements. The following highlights of the Michigan Elevator Rules and University requirements are intended to assist the design effort, but are not a substitute for an understanding of the Rules:

- The University accepts only roped hydraulic lift mechanisms. Screw drive type units are not acceptable.
- A safety device is required at both platform ends. The only code-approved safety device approved by the University is the electric-eye type.
- The University requires that platform guards on both sides of the platform be equipped with handrails.
- The University requires paddle-type switch controls (as opposed to push buttons) for easier use.
- The Elevator Rules require a fused safety disconnect. Locate the disconnect near the lift mechanism, but not in the shaft itself, and not in a location not accessible to the public. Locate the device as unobtrusively as possible.
- The University requires that lift platforms include a side-panel-mounted, spring-loaded seat that, in retracted position, does not impinge on the required clear width of the platform.
- The University requires that lifting device structures be securely fastened to the floor, in accordance with manufacturer's recommendations.
- The University requires a load capacity of 750 pounds.
- The University requires that the minimum platform size should be 13 square feet.

Reference Codes: The following codes and rules affect wheelchair lift installations:

14420

- Americans with Disabilities Act, Uniform Federal Accessibility Standards (ADA/UFAS).
- Michigan Department of Labor Building Code Rules, Chapter 11 - Accessibility.
- Michigan Department of Labor Elevator Rules.

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FIRE PROTECTION

General

All new buildings shall be protected by a hydraulically designed wet-pipe sprinkler system, designed to comply with requirements of NFPA and Factory Mutual (FM).

The University normally requires the installation of wet-pipe sprinkler systems in existing buildings undergoing major infrastructure upgrade not presently protected by fire protection systems.

In existing buildings with hydraulically designed systems, any additions, deletions and/or changes shall not compromise the integrity of the system. Water supply shall be tested and improved as required to meet requirements of NFPA, FM and City of Ann Arbor Standards. A/E shall arrange for testing by U-M Plumbing Shop through U-M Project Coordinator.

Provide standpipe system where required by code.

Related Sections

U-M Design Guideline Sections:

[104400 - Fire Extinguishers](#)

[283100 - Fire Detection and Alarm Systems](#)

U-M Master Specification Sections:

[211313 - Wet Pipe Sprinkler Systems](#)

[213113 - Fire Pumps](#)

Design Requirements

Design drawings (plans) shall include, at a minimum, location of :

- In-coming water supply and fire department connection(s) (Siamese)
- Fire pump and controller, jockey pump, and test header
- All risers, standpipes, zone control valves, fire department valves and fire hose cabinets
- All mains four inch diameter and larger
- Inspector test /drain, service drains
- Sprinkler head locations, sprinkler zoning (with area and criteria stated)

Design shall include fire protection system riser diagram, with at minimum:

- In-coming Water supply and Siamese connections
- Fire pump and controller, jockey pump, and test header
- All risers, standpipes, zone control valves, flow switches, fire department valves and fire hose cabinets

- Inspector test /drain

Design shall include, at minimum, calculation, selection and detail of in-coming water service, fire department connection, fire and jockey pumps, test header, stand pipe/ inspector test/ zone control valves, pipe penetrations, and special systems.

Wet Suppression Systems

Sprinkler density shall be per U-M Master specification.

Discharge from test connections be piped to building exterior or indirect drain of adequate capacity.

Provide dry pendant heads for any room operating at or below 40° F (including cold rooms, environmental rooms and freezers). For areas where piping is subject to freezing, use pre-action system for areas over 2,000 sq ft. and antifreeze protected system for area less than 2,000 sq ft..

Wet pipe sprinkler system shall normally be installed throughout including electrical rooms, substations, mechanical rooms, telephone closets, and computer rooms.

Fire Pumps

Install automatically controlled fire pumps on all fire protection systems where hydraulic calculations indicate that the city water pressure is not adequate to supply the building sprinklers and/or standpipe systems. Fire pump size shall be based on the requirements of NFPA. Water supply to fire pumps shall meet the requirements of NFPA. When a fire pump may feed multiple buildings, special approval from the University Project Coordinator is required for issues related to fire alarm system coordination; possible multiple building conflagrations; and system sectionalizing.

Jockey Pumps

Install jockey pumps on all fire protection systems where flow is detected and monitored, even if a fire pump is not required. Jockey pump head shall be adequate to maintain static pressure required at the top of the system. Size pump flow per NFPA.

Special Systems

Special fire suppression control systems should be located outside the area served. Supply cylinders should be stored in a room or location other than the protected room. A separate room is preferred.

Dry chemical extinguishing systems should be used in all kitchen and cooking locations where grease and oil are used.

Material Requirements

Pipe material per UM Master specifications.

Installation Requirements

Shop drawings shall be forwarded to FM, the Architect/ Engineer and the State of Michigan Bureau of Construction Codes and Fire Safety. Refer to U-M Master Specification.

Install sprinkler heads in center of 2'x2' ceiling tiles, and in center of 2'x2' area for 2'x4' ceiling tiles.

Pressure Testing

Pressure test fire protection systems per NFPA and FM.

Pressure testing is not required for minor relocations of sprinkler heads.



PLUMBING DESIGN

Scope

General plumbing design, booster pumps.

Related Sections

U-M Master Specification Sections:

[22 1123 Domestic Water Booster Pumps](#)

Design Requirements

New Construction

Potable hot water should be obtained from the Central Campus Power House, as delivered through existing utility tunnels. The A/E should coordinate the tie-point to the existing tunnel distribution system with the University's Utilities Engineer through the University Project Coordinator. Prior to this coordination meeting, the A/E should calculate the maximum demand and average consumption requirements of the new facility.

Physically handicapped hot water should be tempered with cold water to maintain 110°F water at the fixture. Provide check valves in both hot and cold connections to tempering valves. Pressure compensating designs shall always be used.

In all new facilities the hot water distribution system shall be of the continuous recirculation design.

Renovation

Potable hot water to meet the needs of new fixtures in renovation projects should be obtained from the existing building system.

The A/E must demonstrate to the satisfaction of the University Project Coordinator that the existing building distribution, primary heating and secondary heating systems are sufficiently large to support the new demands imposed due to the addition of fixtures in a renovation project without adversely affecting other users within the buildings. If the existing systems need to be enlarged, this determination should be made early enough for funds to be allocated within the renovation project.

Domestic Water Booster Pumps

U-M Master Specification Section 22 1123 shall be used as the basis for domestic water booster pump specifications on projects. The A/E shall edit the U-M specification to make it project specific. Turn on hidden text and read all spec. editor's notes when editing the specification.

Typically specify variable speed systems. Consider constant volume staged pump control when friction losses are low relative to fixed head (static head and residual pressure) requirements.

When using variable speed pumps, the pressure sensor(s) used to provide the controller input of distribution pressure should be located at the most hydraulically distant location, in a location accessible for maintenance. The sensor may be located in a small reservoir tank (approximately 5 gallon capacity) which will act as a capacitor to dampen out the impulsive pressure changes.



PLUMBING SPECIALTIES

Scope

Water hammer arrestors, back flow preventers, pressure reducing stations, city water meters, mixing valves (hand washing), floor drains, trap primers, eye washes.

Related Sections

U-M Master Specification Sections:

[221119 Domestic Water Piping Specialties](#)

[224200 Plumbing Fixtures](#)

U-M Standard Details:

[15300001 - Fire Service System Detail](#)

[15411001- Domestic Water Service System Detail](#)

Design and Installation Requirements

Water Hammer Arrestors

Water hammer arrestors shall be elastic chamber type in stainless steel casings certified to PDI standard WH 201, as specified in U-M Master Specification 221119.

Install ball valves for isolating water hammer arrestors for service.

Backflow Prevention

Utilize the U-M details indicated above. These details are intended to reflect both City of Ann Arbor and U-M requirements, but shall be revised as required to make project specific (e.g. to reflect parallel backflow preventers for those projects using such an arrangement). For reduced pressure zone type back flow preventers, indicate where the preventer drain is to be routed to.

Type of Back Flow Prevention Device Required:

The type of backflow prevention device *at the building entrance* must be approved by the City of Ann Arbor. The following reflects what is typically acceptable to the City, projects should therefore initially propose (with explanation) the following backflow prevention devices for City approval. *In all cases, correspondence with the City shall be made through the U-M Design Manager.*

Domestic Water At Building Entrance:

All building types except hospital and medical buildings, and high chemical hazard buildings:

Buildings without pressure booster pumps and a single feed from the city main: No back flow prevention required at entrance. Protect individual backflow hazards within the building with the type of backflow prevention device required by code, located at the hazard.

Buildings with two or more feeds from the city main, or with pressure booster pumps: Testable UL approved double check valve assembly on each feed from the city main. Protect individual backflow hazards within the building with the type of backflow prevention device required by code, located at the hazard.

Hospital or medical buildings, and high chemical hazard buildings:

Provide UL approved reduced pressure zone (RPZ) backflow preventer (BFP) type. Normally provide two RPZ assemblies each sized for 50% of the total required flow rate, piped in parallel, to allow one RPZ to be repaired while the other remains in service. Note that the City does not consider most lab buildings as high chemical hazard buildings. Protect individual backflow hazards within the building with the type of backflow prevention device required by code, located at the hazard.

Fire Service At Building Entrance, All Building Types:

Normally a testable double detector check valve assembly approved for fire service is acceptable. Protect individual backflow hazards within the building, e.g. a glycol zone at a loading dock, a small dry pipe zone chemically protected against microbiologically induced corrosion (MIC), with an RPZ BFP device located at the hazard. For buildings where extensive portions of the fire protection system are chemically treated to avoid MIC or for other purposes, provide a RPZ BFP device at the building entrance. Normally provide two RPZ assemblies each sized for 50% of the total required flow rate, piped in parallel, to allow one RPZ to be repaired while the other remains in service.

Back Flow Prevention and City Water Meters Located in Vaults:

Contact City of Ann Arbor through the U-M Design Manager for specific requirements regarding vault construction.

Individual Hazards Within Buildings:

Install backflow preventers within building as required to isolate hazards from distribution piping. Typical locations are make-up to chilled and heating water systems and cooling towers, and equipment connections, such as lab and vivarium equipment. When cost effective, aggregate such connections onto a non-potable water circuit to reduce the number of BFP assemblies, in particular RPZ type. When RPZ type BFPs protect systems that produce rapid pressure fluctuations downstream of the RPZ, provided a soft seated non-slam check valve immediately downstream of the RPZ. This prevents spitting out the RPZ drain port. Examples are systems with fast closing valves or rapidly cycling pumps (RO machines).

Pressure Reducing Valve (PRV) Stations

The A/E should separate the potable water distribution risers in high-rise buildings with only the upper floors served by booster pumps to preclude the need to add PRVs to the lower floor piping.

The PRV shall be sized for 25 percent reserve capacity at a 250 psi working pressure.

As appropriate, PRVs should be equipped with a smaller auxiliary regulator to handle low demands. The valve should include a full complement of gauges and accessories.

Cold Water PRV set points shall be coordinated with hot water system pressure and/or hot water PRV set points, in particular when using the Campus hot water system, to prevent significant pressure imbalance between the two systems.

City Water Meters

Each building shall contain a water meter.

Provide calculations demonstrating the expected range of city water flow rate at the building entrance, for City of Ann Arbor review. For new buildings as well as major renovations in existing buildings, the size of the meter will be negotiated with the City. The City may request that existing meters be replaced. *In all cases, correspondence with the City shall be made through the U-M Design Manager.*

A separate city water meter is required for the following:

- Domestic water (building entrance)
- Cooling tower make up water
- Cooling tower blow down
- Irrigation system
- Other significant uses which do not ultimately discharge to the city sewer

Route cooling tower overflow drains through the cooling tower blow-down meter.

As indicated on U-M's Fire Service System Detail, for fire service to a building, the City will provide a FM and/or UL approved bypass meter for the testable double detector check valve assembly.

Coordinate meter installation with the University Design Manager. The meters shall be purchased by the University (include cost in project budget) from the City of Ann Arbor. Installation shall be performed by the contractor.

City magnetic flow meters require 120VAC power with a lockable disconnect located at the meter.

City meters require a remote read-out device (a small, wall mounted box) hard-wired to the City meter. This allows the City to read the meter remotely with wireless technology. The City

system has good range and typically can read the device even when mounted on a high building roof. The remote read-out device must be mounted above grade and normally should be located on an outside building wall. However, the device usually works when mounted inside the building on an outside wall, which may be preferable when the distance between the meter and an accessible outside wall location is excessively long. Devices that don't work will require relocation. Meters located outside (e.g. on a roof near a cooling tower) can have the read-out device mounted at a convenient, appropriate location near the meter. In all cases the device must be mounted at a location accessible (no ladders required) to a City meter technician; inside locations should typically be mechanical rooms.

Thermostatic Mixing Valves for Hand Washing Facilities

The Michigan Plumbing Code section 607.1 (2) (h) has been modified by local rule as follows:

An ASSE 1070 mixing valve (water temperature limiting device) is permitted to control up to 5 accessible plumbing fixtures within the same room. The ASSE 1070 mixing valve shall be certified for a minimum flow rate of 0.5 gpm or less.

Therefore accessible plumbing fixtures at U-M do not require dedicated mixing valves for the conditions stated above. This modification is incorporated into the U-M Plumbing Fixture Specification 224200.

Floor Drains

Generally, floor drains shall not be installed in laboratory areas or below emergency showers. Consult with the U-M Design Manager and building users for possible exceptions. Consider need for installing floor drains at high traffic building entrances (e.g. below walk-off mats).

Trap Primers

Trap primers are not required at the University of Michigan, regardless of Michigan Plumbing Code dictates, except for high hazard circumstances, (eg., BSL3 and BSL4 labs), and applications where a dried trap might pose an undetected IAQ problem, (eg., floor drains located inside air handling units), or where it is difficult to re-prime a trap, e.g. below walk-off mats. Therefore trap primers should not be specified for toilet room, mechanical room, safety shower, and similar low hazard floor drains. The Designer shall identify high hazard or other circumstances as mentioned above and include trap primers for such drains. For drains requiring trap primers, the use of multi-trap primers, including electrically operated types, is permitted. Multi-trap primers should conform to ASSE 1018 or ASSE 1044, but do not have to be specifically listed as conforming to those standards, provided their design incorporates an ASSE approved back flow prevention device.

Emergency Eyewashes and Showers

Freestanding eyewashes shall be designed to drench both eyes simultaneously and have a waste line connected to the building sanitary waste system.

Water supplies to eye washes and showers shall be tempered.



HIGH PURITY WATER SYSTEMS

General

This section describes design requirements for high purity water systems generally used to supply laboratory sinks and equipment, typically known as Reverse Osmosis/De-ionized (RO/DI) systems. This guideline also addresses RO make-up for clean steam humidification systems and soft water make-up for boilers.

Related Sections

U-M Design Guideline Sections:

[230000 – Basic Mechanical Requirements](#)

U-M Master Specification Sections:

[220514 - Variable Frequency Drives](#)

Schematic Drawings:

[RODI DG Schematic.pdf](#)

[RO DG Schematic.pdf](#)

[Softener DG Schematic.pdf](#)

System Performance Criteria

The A/E shall determine system performance based on a careful evaluation of specific program requirements. High purity water systems typically have high first and on going operational costs, therefore the A/E shall take particular care not to “over-specify” the system. The proposed system performance will be presented no later than SD phase, for approval by the U-M Design Coordinator. It shall be updated through CD phase, as the requirements for the exact equipment served becomes more precisely determined.

The A/E shall provide the following design criteria for approval:

- Make-up rate in gpm
- Daily production in gallons per 24 hour day
- Storage tank size (gallons)
- Distribution loop flow rate (gpm) and head (ft.)
- Distribution loop temperature
- Primary DI loop (to storage) product quality: Resistivity (megohm-cm), silica, total organic carbon (TOC), sodium, chloride, sulfate.
- Distribution loop water criteria: Resistivity (megohm-cm) , silica, TOC, sodium, chloride, sulfate, oxygen, boron, particulate (maximum particle size and quantity per unit volume), bacteria (viable per ml), Ph.

- Point where distribution loop water criteria is to be achieved (e.g. at point of use, leaving post filter, etc).
- Outline calculations identifying how make-up rate and distribution flow rate and head were determined

Not all the criteria listed above will apply to a project, for instance TOC limits typically apply to semi-conductor projects, but not to generic research labs. The A/E shall explicitly indicate which criteria are not applicable when providing design criteria for approval.

Water resistivity above 10 megohm-cm (CAP-1) is not typically required for general lab use, however the A/E shall determine exact resistivity requirements based on the program.

Plans and Specification Requirements

Include a clear statement of the system performance criteria within the specification.

- This statement shall include all the system performance criteria listed above.
- Obtain the most recent city water analysis and include in the specification.
- Include the minimum expected feed-water temperature.
- Indicate that system performance be guaranteed based on the stated feed-water analysis, including temperature.

Plans shall include a detailed system schematic, showing the arrangement of major system components, instruments, meters, isolation valves, gages, etc.

The system schematic shall also indicate make-up flow rate, distribution flow rate, distribution pump GPM and head, and storage tank volume.

The system schematic shall indicate piping materials for feed water, RO water, distribution supply, and distribution return.

Typical Component Arrangement and Requirements

The following sections outline the typical RO/DI system arrangement at U-M and the requirements for individual components, starting at the feed-water input. Outline level schematics for typical RO/DI, RO, and softener systems are provided for reference under the Related Documents section of this Guideline. It is not the intent of this section to dictate exact system arrangement; the A/E shall design a project specific system to meet program requirements. However, variances from this arrangement shall be called to the attention of the U-M Design Coordinator, for approval.

Feed Water

Provide back-flow prevention (BFP) at the feed water input to the system.

Provide a pressure gage up and downstream of the BFP.

Evaluate the benefit of preheating feed water to improve RO system performance (by improving RO membrane production rate, allowing reduction in RO size). Consider mixing valve or heat exchanger. Preheating shall be evaluated on large systems (make-up rates above 10 GPM), however its use typically mandates a distribution loop cooling heat exchanger be employed as well.

Feed Water Pre-Filter

Provide simplex 10 micron cartridge (disposable element) filter with bypass. Specify minimum 20" long cartridges. Provide pressure gages across filter.

Water Softener

Duplex softener arrangement, demand (flow) initiated type, common brine tank, shall be provided. Very small systems not requiring 24/7 production may utilize a simplex arrangement. For simplex arrangements, specify demand initiated/timer based regeneration type softeners interlocked to prevent RO operation during softener regeneration cycle.

Provide a hard piped bypass around the softener arrangement.

Softeners for boiler water make-up systems shall be duplex demand initiated type.

Brine tanks shall be specified large enough to hold enough salt for 1 month's soft water production. Maximum brine tank height shall be 4 feet. Indicate that the brine tank overflow is piped to a floor drain.

For systems with make-up rates above 15 GPM or with an estimated salt use in excess of 1000 lb.s/month, bulk brine storage system shall be provided.

Provide pressure gauges across softener bank.

Carbon Filter

Provide duplex carbon filter piping arrangement. U-M utilizes a carbon bottle exchange program where a vendor replaces expired carbon bottles, therefore back-washing type carbon filters should normally not be specified and will only be considered on extremely large systems. The design should indicate all required piping for a duplex arrangement including flexible hoses for carbon filter bottle connection. Indicate carbon filters are supplied by U-M.

Provide pressure gauges across carbon filter bank.

Reverse Osmosis Prefilter

Provide simplex 1 micron cartridge (disposable element) filter without bypass. Specify minimum 10" long cartridges. Provide pressure gages across filter.

Reverse Osmosis System

Specify a skid mounted system furnished with controls providing automatic and manual operation. RO system shall include low pressure pump cut-out, relief valve, meters to monitor product and reject flow rates (typically rotometers) and isolation valves to allow pump and membrane change-out.

Provide a resettable totalizing water meter that indicates total RO product produced.

Mixed Bed De-Ionization Bottles (Make-Up Loop)

Not normally required. A pair (or multiple pair on large systems) of mixed bed resin bottles, located upstream of the storage tanks, may be required for ultra-pure/semi projects. The same piping arrangement and bottle exchange requirements described for the distribution loop mixed beds applies. See below.

Resin Trap

If mixed bed DI bottles are provided in the make-up loop, provide a resin trap downstream consisting of a basket strainer with a 1/64" mesh opening strainer element. Provide pressure gages across the strainer.

Storage Tank(s)

The A/E shall carefully evaluate storage tank size based on program requirements. Minimum tank sizes adequate to hold a 1/2 day's worth of production are typical.

Tanks shall be translucent with a bottom sloped to the outlet connection. Tank vents and over-flows shall be protected by suitable filters. Provide a tank drain piped to a floor drain.

Tanks shall be equipped with clear, flexible plastic tube ("tygon") type site glasses. Provide isolation valves on site glasses. Specify external tank level sensors located in site glass piping that allows disconnecting the site glass tube to test the level controls without draining the storage tank.

Distribution Pumps

Normally provide 100% redundant distribution pumps.

Indicate isolation valves and pressure gages on the inlet and outlet of each pump, and provide a check valve on the outlet side of each pump.

Provide a means to control pump flow. Variable frequency drives (VFDs) are preferred, except for very small systems. VFDs shall comply with UM master spec section Variable Speed Drives.

Specify a low pressure cutout switch for the distribution pumps.

Due to the relatively fragile piping materials used on RO/DI systems, often at high pressures, a relief valve with discharge routed to the storage tank is recommended.

Ultraviolet Sterilizers (Upstream of Distribution Loop Mixed Bed De-Ionizers)

UV filtration upstream of the mixed beds is not typically required except in special circumstances, such as systems serving semi-conductor fab.s.

Mixed Bed De-Ionization Bottles (Distribution Loop)

U-M utilizes a mixed bed bottle exchange program where a vendor provides re-generated resin bottles as on-line bottles expire. Therefore the A/E specification should indicate that the mixed beds are provided by UM, i.e. *not* provided by the contractor. The standard bottle size utilized in this program is 3.6 cubic feet. Therefore the A/E shall design the mixed bed “farm” utilizing this bottle size. Since bottle capacity is typically 3-4 gpm/cubic foot of resin, multiple pairs of bottles are normally required. Each bottle pair shall be indicated as piped in series, with a “quality light” located between each bottle pair to indicate when the upstream bottle quality has degraded.

On extremely large systems, larger bottle sizes may be considered, not to exceed 15 cubic foot size. Larger bottle sizes must be approved by U-M Plant Engineering.

Normally Type 1 resins are utilized on U-M laboratory systems. Ultra pure systems (e.g. semi-conductor applications) may require special mixed bed resins, such as virgin semi-conductor grade. Such resin requirements shall be reviewed and approved by the U-M Design Coordinator.

Ultraviolet Sterilizers (Downstream of Distribution Loop Mixed Bed De-Ionizers)

Provide a simplex UV sterilizer downstream of the distribution loop mixed beds.

Provide a hard piped bypass around the UV sterilizer.

Post Filters, Distribution Loop

Provide simplex cartridge (disposable element) type filter with bypass, equipped with 0.2 micron absolute filter elements. Specify minimum 20” long cartridges. Provide pressure gages across filter.

Evaluate higher levels of absolute filter performance (“ultra filters”) for ultra pure or critical systems (e.g. semi-conductor applications).

Heat Exchanger, Distribution Loop

Provide when the program dictates that a maximum distribution loop temperature be maintained. Evaluate if a distribution loop heat exchanger is required due to feed-water pre-heating or other factors, to maintain loop temperatures within reasonable limits. Give consideration of final RO/DI water use, pipe expansion concerns, etc. Plate and frame type heat exchangers are preferred.

Sample Ports

Provide sample ports at each location shown on the sample system diagram.

Component Redundancy

For critical systems, in addition to the minimum redundancy requirements specified in the above sections, provide:

- Multiple storage tanks (50/50 or similar type arrangement in lieu of a single tank)
- Redundant final filters

Redundancy for other components, though not typically recommended, may be appropriate. A/E shall evaluate with U-M user and U-M Design Coordinator.

Distribution Piping

RO/DI systems shall be designed for continuous circulation, without dead legs. Dead legs are defined as any dead-ended section of pipe more than 4 pipe diameters long that occurs when a valve is closed. Small less critical systems (total distance from point of use in the 100 foot range) may be non-circulating type

Provide a means of balancing and reading (gpm; rotometers one method) each major supply and return sub-loop, for example: on a floor by floor basis.

Hi purity water faucets with barbed terminations should be the recirculating type with integral back flow preventer, spring return handles preferred.

A back-pressure regulator is typically required on the system return main (near the connection to the storage tank).

Diaphragm or butterfly valves should be specified for supply piping downstream of the distribution loop mixed beds. However, in lower grade systems, carefully evaluate the benefit of diaphragm valves due to the high cost of this valve type. Ball valves may be used on returns and else where. Valve material should typically match associated piping material.

Provide pipe hanger details for hanging plastic pipe.

Bare polypropylene piping should not be run in plenum returns.

Piping Materials

Typical piping materials for RO/DI systems shall be as follows:

RO skid to Storage Tank:

- Sch 80 CPVC, solvent joints (all systems)

Storage Tank to inlet of Distribution Mixed Beds:

- Polypropylene (research labs, and ultra pure applications such as semi)

From Distribution Mixed Bed Outlet (and all RO/DI supply piping in building):

- Polypropylene/fused joints (research labs)
- PVDF/fused joints (ultra pure applications such as semi)

RO/DI distribution loop return piping:

- Polypropylene/fused joints (research labs and ultra pure applications such as semi)

The A/E shall carefully evaluate piping materials, considering specific project performance requirements. PVC/CPVC piping may be considered for low grade high purity applications.

For RO systems serving clean steam generators, piping may be Sch 80 CPVC/solvent joints. Specify stainless steel piping near clean steam generator connection point due to high temperatures in the vicinity of the generator. Provide a check valve in the make-up line near the connection to the generator.

Controls

Specify a complete, central control panel with the following features:

- Distribution loop supply water resistivity and alarm
- Total RO water produced
- Tank level control
- Distribution pump low pressure alarm light
- Distribution pumps off alarm light (activated only if both distribution pumps are statused" off")
- High storage tank level alarm light (latching, requiring manual reset).
- Low storage tank level alarm light (latching, requiring manual reset).
- Common alarm dry contact, for DDC monitoring. To activate upon any alarm condition above, or any alarm condition occurring on the RO skid.
- Panel on/off switch

Though typically not required, the A/E shall consider if other monitoring and alarm features are appropriate, based on the planned use for the system. Small low grade high purity applications may not require all the control features outlined above.

The RO skid shall utilize a PLC based controller. Specify that the vendor shall provide U-M all software, pass codes, etc. to allow U-M full access to the controller programming and settings, as well as a back-up copy of the project specific program.

Electrical

Do not specify a single point power connection for the system. Instead, indicate power connections to the individual components: Softener, RO Skid, control panel, distribution pumps, etc.

The RO vendor shall be designated as providing combination starters for the RO skid pumps, and VFDs (or combination starters) for the distribution pumps.

Start-up/Certification

The entire distribution loop piping system (supply and return) shall be sanitized (with sodium hypochlorite, similar to sanitizing domestic water systems) prior to putting the system into operation. Mixed beds shall not be connected to the distribution piping during sanitization.

The RO/DI system supplier shall provide technicians specifically trained on RO/DI system start-up, for system start-up.

During start-up, the vendor shall, in the presence of U-M, delete the PLC program and demonstrate reloading the back-up copy of the software program.

All systems shall have performance certified by an independent 3rd party, including the taking of samples. On large systems, multiple samples shall be taken, e.g. one per floor. The first sample shall be taken by dumping the system make-up rate for 24 hours, and then taking a sample at a point of use location designated by the owner. The system shall then be run 1 week, and additional sample(s) shall be taken at point of use locations designated by the owner. Specify that a certified performance report shall be provided to the owner.



MOTORS

Scope

This sections covers requirements for most motors 200 HP and less. This section does not apply to fire pumps, elevators and sealed refrigeration motors, nor does it apply to small motors with stepped down voltage below 115V.

Related Sections

U-M Master Specification Sections:
[220513 - Motors](#)

General

U-M Master Specification Section 220513 Motors shall be used as the basis for the motor specification on all projects. The A/E shall edit (append) the U-M motor specification to make it project specific; however do not generally modify the fundamental motor attributes described in the specification. Turn on hidden text and read all spec. editor's notes when editing the specification.

Phase and Voltage

Motors 1/2 HP and larger should be three phase.

Single phase motors may be rated for 115V, 200V, depending on the application, and building power.

Three phase motors should be rated for 460V wherever possible. Where building power does not include 480V distribution, review options with Project Coordinator and consider adding a step-up transformer, and using 460V motors. The long term objective in most buildings is to have three phase distribution at 480V.

Power distribution system serving large motors (100HP and larger) should be examined to ensure across the line motor starting will not adversely impact the system. Consult Project Coordinator and other appropriate University personnel in these applications.

Three Phase Motor General Requirements

For most applications, including air handlers, motor enclosures for fans and pumps should be Open Drip Proof (ODP) type. For cooling towers and other harsh environments, use Totally Enclosed Fan Cooled (TEFC) motors.

Multiple Speed Motors

With the increased viability of variable speed drives, applications for multiple speed motors are few and far between. Where three phase motors require multiple speeds, there shall be a separate winding for each speed. Coordinate electrical requirements carefully with electrical designer.

Motors for Variable Frequency Drives

Review and verify with both the drive and motor manufacturer the maximum cable length for each drive. Also consider other requirements such as RFI that may affect the cable length.

Consult manufacturer guidelines and provide proper grounding.

For all hospital funded projects, provide AEGIS SGR (Shaft Grounding Ring) for all VFD motors. In addition for motors 100 HP or above, also provide an insulated ceramic bearing assembly on the non-drive end of the motor.



VARIABLE SPEED DRIVES

Related Sections

U-M Design Guideline Sections:

[220513 Motors](#)

[220514-H Supplemental Variable Speed Drive Guideline for UMHC Facilities](#)

U-M Master Specification Sections:

[220513 Motors](#)

[220514 Variable Speed Drives](#)

Variable Frequency Drive Specifications

U-M Master Specification Section 220514 Variable Speed Drives shall be used as the VFD specification on all projects. Edit U-M VFD spec. 15960 to make it project specific. Turn on hidden text and read all spec. editors notes when editing the specification.

Pay special attention to the following when revising the spec. to make it project specific:

- VFDs used in U-M Hospital and Health Care Facilities may need to be 18 pulse type. Refer to the UMHC Design Guideline 220514-H, and modify the specification to indicate 18 pulse VFDs when required for UMHC facilities. See additional discussion on VFD pulse requirements, below.
- Additional editing is not typically required. Do not strike features required by the specification without the consent of the U-M Design Manager. Features listed are typically required for all VFDs, even if not immediately utilized by the subject project.

Pulse, THD, Disconnect, Early Break Contact, and Motor Requirements

U-M's master specification for VFDs requires minimum 6 pulse PWM type VFDs. With the exception of some UMHC locations, 12 or 18 pulse VFDs are not required provided the VFD complies with all other aspects of the U-M master spec. Therefore do not indiscriminately specify higher pulse VFDs.

The U-M VFD master spec. limits the maximum current total harmonic distortion (THD) to not more than 100% of the VFD input current waveform at any VFD operating speed from 20% to 100%, and requires the manufacturer to provide minimum 3 percent AC line reactors and/or minimum 5 percent DC link reactors. It additionally specifies that if the maximum THD is exceeded, the manufacture shall provide additional line reactors to reduce the THD to within specified limits. *Therefore the AE must include the requirement that each VFD's current and voltage THD be measured in the electrical testing section of Division 16.*

Avoid installing VFDs on the same bus as capacitors or harmonic sensitive equipment.

The U-M VFD spec. 220514 requires all VFDs to include a disconnect switch that is pad-lockable in the open position.

For VFDs that are in sight from the motor, no separate disconnect is required between the VFD and the motor.

For VFDs that are not in sight from the motor, provide a separate disconnect between the VFD and the motor that is in sight of the motor.

Exception for VFDs serving air handlers:

If the VFD is in sight of the door that accesses the air handler section containing the motor, a disconnect is not required between the VFD and the motor. If the VFD is not in sight of that door, provide a disconnect adjacent to the door.

When a common VFD serves multiple direct-drive fan array motors, each motor shall be equipped with a separate disconnect switch. These disconnects shall be located at the door. Alternatively, they can be located in the VFD if in sight of the door, after verifying with the VFD manufacturers that it's practical given project conditions. In all cases maintain proper NEC clearances.

“In sight from the motor” is defined by the National Electrical Code as being visible from and not more than 50 feet from.

When a separate motor disconnect switch is provided, the disconnect shall include automatic “early break” auxiliary contacts that deactivate the VFD whenever the motor disconnect switch is opened. The wiring associated with the early break contacts may be run in the same conduit as the power wiring to the disconnect. Assure the electrical drawings indicate the required early break contact wiring. When a common VFD serves multiple direct-drive fan array motors, early break auxiliary contacts are not required.

U-M requires motors driven by VFDs be inverter duty rated per NEMA MG-1 Part 31.

For insulated motor bearings or shaft grounding brushes, see Design Guideline 220513 Motors for requirements.

Redundancy and VFD Bypass Devices

VFDs serving non-redundant equipment shall be scheduled with a bypass device. Examples:

- A variable volume air handler with a single supply and a single return fan: A bypass device is required on both VFDs.
- A variable volume air handler consisting of (2) supply fans and (2) return fans, each of which is sized to handle 50% of the peak load: A bypass device is required on all (4) VFDs.

- A pump set consists of (3) pumps each sized to handle 50% of the peak load, therefore a fully redundant pump has been included. None of the pump VFDs should be scheduled with a bypass device.

The electrical and mechanical systems associated with the VFD shall be sized and braced to allow the driven system to safely start and operate when the VFD is placed in bypass mode. Provide over pressure protection or similar devices that prevent damage to the driven mechanical equipment and associated components such as duct and pipe, when the motor is operated (full speed) across-the-line via the bypass device.

Although rarely required, evaluate the need to provide an automatic bypass feature that automatically connects the motor directly across the line if the VFD faults or fails. When an automatic bypass is provided, motor overload protection, run permissive, and safety circuits shall remain active with the VFD in automatic bypass.

General Design and Design Document Requirements

When a piece of equipment or a system includes multiple motors (e.g. an AHU with a supply and a return fan), provide a VFD for each motor. Controlling multiple motors with the same VFD is discouraged; exceptions may be made when a common VFD serves multiple direct-drive fan array motors. Consult with the U-M Design Manager.

The AE shall schedule the VFDs on the mechanical drawings. The following minimum information shall be indicated in the schedule: Equipment Served, Horsepower, Voltage, Short Circuit Current Rating, Input Signal (typically 4-20 mA), Bypass Device Y/N, Emergency Power Y/N.

U-M's normal convention is to have the mechanical trade furnish the VFD and the electrical trade install the VFD.

VFDs should be located indoors and as close to the driven motor as practical.

VFDs are considered motor controllers by the NEC. Do not locate piping or ductwork directly above the VFD. Maintain proper NEC clearances in front of the VFD panel, typically 42" deep.

VFDs may be mounted on walls or may be free standing. Free standing units shall be designated as mounted on a Unistrut style rack. VFDs shall not be mounted on the housings of mechanical equipment.



THERMOMETERS AND PRESSURE GAUGES

Scope

Requirements for thermometers and pressure gauges.

Related Sections

U-M Master Specification:

[220519 - Thermometers, Pressure Gauges, and Accessories](#)

Standard Details:

[15130001 - Thermometer Installation Detail](#)

[15130002 - Pressure Gauge Detail](#)

Design and Application Requirements

U-M Master Specification Section 22 0519 shall be used as the basis for thermometer and pressure gauge specifications on projects, with the exception of fire protection. This specification contains the minimum requirements for thermometers and pressure gauges at U-M. Project specific requirements may dictate devices with additional features, higher pressure/temperature ratings, etc. The A/E shall therefore edit the U-M specification to make it project specific. Turn on hidden text and read all spec. editor's notes when editing the specification.

Mercury thermometers are not to be used.

Single pressure gauges should be used across pumps and strainers, piped so that suction/discharge- upstream/downstream pressures can be read separately.

Installation Requirements

The A/E shall show on the drawings or details the locations of all thermometers and gauges.



VALVES

Scope

Valves for fire protection, plumbing, steam and hydronic service.

Related Sections

U-M Master Specification Sections:

[22 0523 Valves](#)

Design and Application Requirements

General

U-M Master Specification Section 22 0523 shall be used as the basis for valve specifications on projects, with the exception of valves for fire protection. This specification contains the minimum requirements for valves at U-M. Project specific requirements may dictate valves with additional features, higher pressure/temperature ratings, etc. The A/E shall therefore edit the U-M valve specification to make it project specific. While many valve service types are covered in the specification, not all are included. Add to the specification , service types not included, as required for the project. Turn on hidden text and read all spec. editor's notes when editing the specification.

Valves shall be specified with seats, stem seals and disc materials compatible for intended fluid, temperature, pressure and service. Valve pressure and temperature ratings shall be specified to meet or exceed those of the system in which they are installed.

Strainer blow-down valves shall be quarter turn ball valves.

Fire Protection

Valves for use in fire protection systems shall be FM approved.

Potable Water Systems

Valves in city water mains exterior to the building shall comply with City of Ann Arbor requirements.



MECHANICAL IDENTIFICATION AND PAINTING

General

In general, follow the guidelines below when specifying identification and painting of mechanical piping, ductwork and equipment. Unless otherwise indicated, these guidelines are not intended to restrict or replace professional judgment.

Related Sections

Related References

In general it is the University's intention to follow industry practice, and to use existing standards to establish these guidelines.

- ANSI A13.1 - Scheme for the Identification of Piping Systems

Piping and Ductwork Identification

All pipes in all exposed locations shall be identified with factory fabricated, precurled labels securely attached to the pipe. Film markers are not acceptable, as they tend to wear off with time. Ductwork mains and all fume hood exhaust ductwork require labeling.

Clearly identify direction of flow in piping and ductwork with arrows. Arrows and markers shall be mounted to provide unobstructed visibility from floor level.

Pipe and Ductwork labels should indicate full name of service as indicated below. Abbreviations should be used on drawings only.

Pipe Labeling

Pipe labels should be installed at all access panels or doors, adjacent to valves and branch connections, both sides of floors, ceilings and walls, all major changes in direction, on straight lengths of pipe every 25 feet, and at points of termination (except in occupied spaces).

Identify contents of piping system by both fluid contained and unique temperature and/or pressure (if necessary to distinguish between other systems with same fluid at different conditions); e.g., Potable Hot Water - 110°F vs. Potable Hot Water - 140°F.

Plumbing and Waste Pipe System Labels

Acid Waste
Brine

Drawing I.D.

ACID
BR

Letter and Label Color

Black on Yellow
White on Green

Compressed Air	A	White on Blue
Fire Protection	FP	White on Red
Hazardous Waste	HAZ	Black on Yellow
High Purity Water	DI	White on Green
Hot Water Supply, Potable	HW	Black on Yellow
Hot Water Return, Potable	HWR	Black on Yellow
Natural Gas	G	Black on Yellow
Non-Potable Water	NPW	Black on Yellow
Potable Cold Water	CW	White on Green
Radiation Waste	RAD	Black on Yellow
Sanitary Waste	SAN	White on Green
Silver Recovery	AG	Black on Yellow
Soft Cold Water	SCW	White on Green

Heating and Cooling Pipe System Labels

	<u>Drawing I.D.</u>	<u>Letter and Label Color</u>
Chilled Water Return	CHWR	White on Green
Chilled Water Supply	CHWS	White on Green
Condenser Water Return	CWR	White on Green
Condenser Water Supply	CWS	White on Green
Fuel Oil Return	FOR	Black on Yellow
Fuel Oil Supply	FOS	Black on Yellow
High Pressure Condensate	HPC	Black on Yellow
High Pressure Steam	HPS	Black on Yellow
Hot Water Heating Return	HHWR	Black on Yellow
Hot Water Heating Supply	HHWS	Black on Yellow
Low Pressure Condensate	LPC	Black on Yellow
Low Pressure Steam (15#)	LPS	Black on Yellow
Medium Pressure Condensate	MPC	Black on Yellow
Medium Pressure Steam (60#)	MPS	Black on Yellow
Pumped Steam Condensate	PC	Black on Yellow

Medical Gas Pipe System Labels

	<u>Drawing I.D.</u>	<u>Letter and Label Color</u>
Medical Compressed Air	MCA	Black on Yellow
Laboratory Vacuum	LVAC	White on Blue
Dental Vacuum	DVAC	White on Blue
Nitrous Evacuation	N2OEVAC	White on Blue
Oxygen	OX	White on Green
Nitrous Oxide	NO	White on Blue
Carbon Dioxide	CO2	White or Black on Gray
Helium	HE	White on Brown
Nitrogen	N	White on Black
Medical Vacuum	MVAC	Black on White

Ductwork Labeling

Ductwork labels should be installed at all access panels or doors, both sides of floors, ceilings and walls, all major changes in direction, and on straight lengths of duct every 40 feet.

For ductwork, drawing identification and label should include identification of associated equipment, eg. "Supply Air (AHU-1)" for label, and "SA (AHU-1)" on drawings.

<u>Service/ Duct Label</u>	<u>Drawing</u>	<u>Letter and Label Color</u>
HVAC Supply Air (Equip. #)	SA (Eq.#)	White on Green
HVAC Return Air (Equip. #)	RA (Eq.#)	White on Green
HVAC Exhaust Air (Equip. #)	EA (Eq.#)	Black on Yellow
Outdoor Air (Equip. #)	OA (Eq.#)	White on Green
Fume Hood Exhaust (Equip. #)	FHEA (Eq.#)	Black on Yellow

Equipment Identification

During design phase, A/E shall assign equipment numbers to be used in the construction documents, in conjunction with the Project Coordinator.

Numbers for major mechanical equipment such as air handlers, chillers and pumps should be unique within a building and continue the sequence established by existing equipment. As an example, if air handlers AC-1, AC-2 and AC-3 already exist, then a new air handler should be named AC-4 (not AC-1 or AHU-4 or ACU-4). Although many equipment designators are presently used throughout the University, the A/E is encouraged to use the designators listed below where possible. All major equipment shall be labeled using this designator, engraved on a plastic label and permanently affixed to the unit. Where the first equipment item on a project is not named "...-1", the equipment schedule should note that all the equipment with names preceding it are existing.

All small equipment intended to appear on test and balance reports, including VAV boxes, should be identified on design drawings with a unique number. Field labeling is not required for small equipment.

<u>Drawing I.D. & Equip. Label</u>	<u>Equipment</u>	<u>Drawing I.D. & Equip. Label</u>	<u>Equipment</u>
ACC	air cooled condenser	GEF	general exhaust fan
AHU	air handling unit	GWH	gas-fired water heater
CH	chiller	HTX	heat exchanger
CHWP	chilled water pump	HWB	hot water boiler
CP	condensate pump	HWH	hot water heating pump
CT	cooling tower	P	pump (other than those listed)
CUH	cabinet unit heater	RF	return fan
CWP	condenser water pump	SB	steam boiler
EW	electric water heater	SF	supply fan
FHEF	fume hood exhaust fan	UH	unit heater
FP	fire pump	VP	vacuum pump

Valve Identification

Only special use valves need be numbered on design drawings. However, all valves and regulators, except those directly serving equipment, shall be provided with 1-1/2 inch diameter

brass tags with stamped numbers and letters. Tags shall indicate the system in which installed (using abbreviations listed in "Piping and Ductwork Identification" above), and valve number for systems having more than one valve.

Contractor shall provide a separate directory and drawing for plumbing, heating, and air conditioning systems. Drawing shall be scaled as required to indicate the location of each valve. A copy of the drawing shall be plastic laminated, suitable for framing, and turned over to maintenance for field use. A copy of each drawing shall be included in each copy of the Operation and Maintenance Manuals.

Painting

In general, painting of mechanical components is to be done where needed for component protection, housekeeping or aesthetics, not for identification of mechanical systems. All fire protection piping shall be painted red.

In concealed areas, including shafts and above acoustic ceilings:

Paint is not required for most piping and ductwork.

In exposed areas, including mechanical equipment rooms, and labs with no ceilings:

Paint uninsulated pipe and ductwork the same color as the background ceiling. Consult with architect and Project Coordinator. Insulated pipe and ductwork does not require paint, unless called for by Project Coordinator for aesthetic reasons.

Exterior:

Paint uninsulated pipe and ductwork the same color as the background building, or complementary color as directed by Project Coordinator. Insulated pipe and ductwork does not require paint, provided insulation material does not require paint for protection. Depending on visibility, insulated pipe and duct, and mechanical equipment may be painted to match background, as instructed by Project Coordinator.



MECHANICAL INSULATION

General

Insulation of pipe and duct systems to avoid condensation or to provide personnel protection is required. Cost-benefit analysis and ASHRAE 90A should be used to determine which additional systems should be insulated and the appropriate insulation thickness. A continuous vapor barrier jacket must be provided when condensation is possible. This normally means that hangers and riser clamps may not be in contact with the piping. Insulation of the complete system, including air separators, suction diffusers, chilled water pump casings, shot feeder, airflow measuring stations, etc., is required when condensation is possible.

For normal maintenance and inspection activities, insulation should be segmented for removal without damage to adjacent insulation.

Insulation exposed to outside shall be a weather resistant system, with durable, UV stable, waterproof finish.

Insulation exposed to high physical abuse, such as piping near the floors which is regularly walked over, shall be adequately protected with pre-molded, heavy gage, PVC covers, reinforcing shields, catwalks etc., to ensure the long-term integrity of the insulation system.

Insulation materials should meet applicable requirements of NFPA 90A, and MICA/ NIAC “National Commercial and Industrial Insulation Standards”.

Related Sections

U-M Design Guideline Sections:

[SID-F - Codes and Regulatory Agencies](#)

U-M Master Specification Sections:

[Section 220553 - Mechanical Identification](#)

[Section 221113 - Piping Materials and Methods](#)

Piping Insulation Materials Requirements

General

Fiberglass pipe insulation shall be rigid, pre-molded to size of piping on which it is used.

Indoor Piping

For “hot piping” carrying fluids at 110F and above: Insulate pipe and fittings (excluding unions and valves) using fiberglass insulation with ASJ (all service jacket, with integral

vapor barrier). Closed cell expanded foam insulation (similar to Armaflex) may be used on domestic hot water piping.

For “cold piping” carrying fluids below 70F: Insulate pipe, fitting, valves, unions, flanges and all cold surfaces using fiberglass (with ASJ), or closed cell expanded foam. Ensure all cold surfaces are insulated, and that continuity of vapor barrier is maintained.

Piping carrying fluids between 70F and 110F does not require insulation. Condenser water piping should be considered “cold piping” if used for free cooling.

Indoor pipe insulation can be presized rigid board fiberglass with paintable jacket. Exposed insulation in finished areas should be painted as described in Section 220553.

Tunnel Piping

Piping insulation in tunnels shall include dimpled aluminum jacketing.

Outdoor Piping

For outdoor piping, use insulating materials similar to those stated for indoor use, but add aluminum jacket for fiberglass insulation and premium quality weather resistant coating for expanded foam insulation.

Outdoor compressed air piping should be heat traced and insulated if piping is in service during the winter and if the pressure dew-point is above minus 20F.

Underground Piping

For hot piping (carrying fluid above 110F), a carrier pipe inside a steel or fiberglass jacket pipe, with foam insulation between, is preferred.

Chilled water piping is typically run as uninsulated ductile iron pipe. If ductile iron pipe is not used, consider a carrier pipe inside a PVC jacket with expanded urethane insulation between.

Refer to Section 221113 for pipe material requirements.

Ductwork Insulation Material Requirements

General

Acoustic duct lining should not be used unless part of a double wall duct system with a mylar barrier between the inner duct wall and liner face.

Indoor Ductwork

Indoor ductwork in concealed areas (above ceilings and in closed shafts), may be insulated with blanket type fiberglass insulation with jacket.

Indoor ductwork in exposed areas (such as mechanical rooms, labs with exposed ceilings etc.) should be insulated using rigid board fiberglass with paintable jacket. See Section 220553 for painting requirements.

Particular attention shall be paid to “cold ductwork” to ensure duct supports will not cause condensation.

Exhaust duct shall not be insulated.

Need for insulation on return air ductwork should be evaluated based on air stream and ambient conditions. Typically, air conditioned return duct in unconditioned mechanical rooms should be insulated.

Outdoor Ductwork

Outdoor duct insulation should be high density foam plastic, or rigid fiberglass, mastic sealed and painted with weather resistant finish.

Underground Ductwork

Requirements should be reviewed on a case by case basis with Project Coordinator

Equipment Insulation

Insulate all cold equipment to prevent condensation for the following:

- Chilled water pumps
- Chiller shells and water boxes

Insulate hot equipment as required for personnel protection and on the following equipment:

- Domestic hot water storage tanks
- Large condensate receivers

Installation Requirements

Insulation at joints should not be applied until after pipe, duct and equipment have been final installed, tested, cleaned, and inspected.

All exposed edges of insulation shall be sealed.



BASIC PIPING MATERIALS AND METHODS

General

In general, follow the guidelines below when designing and specifying pipe, pipe fittings, and accessories. Unless specifically indicated otherwise, these guidelines are not intended to restrict or replace professional judgment. Piping materials shall be compatible with systems served.

Related Sections

U-M Design Guideline Sections:

[Division 2 - Sitework](#)

[210000 - Fire Protection](#)

[220020 - High Purity Water Systems](#)

[220719 - Mechanical Insulation](#)

[SBA-H Tunnels](#)

U-M Master Specification Sections:

[Division 2 - Sitework](#)

[211313 - Wet Pipe Sprinkler Systems](#)

[221113 - Basic Piping Materials and Methods](#)

[232116 - Hydronic Piping Specialties](#)

[232216 - Steam and Condensate Piping Specialties](#)

[232300 - Refrigerant Piping](#)

Ductile Iron Pressure Pipe Inside Buildings

In all cases, ductile iron pressure pipe running inside buildings shall be equipped with restrained joints. This includes new construction and renovation work.

Ductile iron pressure pipe should normally not be run inside buildings. A typical case when this is unavoidable is underground domestic, fire protection, or chilled water ductile iron pipe connecting to the associated building piping system. The transition between the underground ductile iron pressure pipe and the building pipe shall be accomplished with a flange located inside the building.

- For new installations, specify that the termination of the ductile iron pipe (and any ductile iron joint inside the building) be factory threaded and equipped with a screw-on, machine tightened, ductile iron flange that complies with ANSI/AWWA C110 and C115, similar to that available from American Ductile Iron Pipe, US Pipe, and others.

For existing buildings with unrestrained plain end or mechanical joint ductile iron piping, replace with restrained flange adapters with actuating screws that break off when tightened to

the proper torque, such as EBAA Iron Incorporated MEGAFLANGE Series 2100. Do not specify restrained flange adapters that do not incorporate break-off actuating screws.

General Material Requirements

Refer to U-M Master Specification for piping and accessory materials and installation requirements, including: Drainage and Vent Piping, Pressurized Plumbing Piping, Hydronic and Steam Piping, Eccentric Fittings, Tees in Welded Pipe, Solder in Copper Piping Joints, Dielectric Protection, Flanges, and Unions – previously addressed in this section. In all cases, pipe materials and accessories must be compatible with systems served (pressure, temperature, corrosion resistance). Master specifications contain extensive hidden text for the specification editor to guide decision making process. Where U-M Master Specifications are used, edit and customize on a project specific basis. Note that only the more typical piping applications are covered in the U-M master specification; assure every pipe application specific to the project is specified. Additional clarification is included in paragraphs that follow.

Mechanical Piping Material Requirements

Refer to U-M Master Specification Sections for details of piping material requirements. Clarifications and exceptions are noted below.

Domestic Cold Water and Hot Water

Domestic Hot Water piping installed in the central campus tunnel system shall use exclusively Victaulic grooved copper pipe and fittings.

Storm and Sanitary Waste and Vent Piping

Vent piping shall be the same as waste piping.

Master specification includes both cast iron and PVC piping. Use cast iron unless specifically instructed by U-M Design Manager to use PVC. While PVC may have some appropriate applications in small projects, there can be smoke/fire related problems with using PVC.

Laboratory Waste and Vent Piping

For most chemistry and biology labs, dumping of acids and other corrosive chemicals is prohibited. As such the waste stream is generally dilute, within Ph limits suitable for discharge to city sanitary sewers. Therefore, in most cases, neutralization pits are not required. Confirm design philosophy on lab waste system with U-M Design Manager.

For general lab applications, above ground lab waste piping is typically specified as corrosion resistant polypropylene, Schedule 40. Joints may be mechanical type or fuse-sealed, depending on application. For new lab buildings, or renovations with extensive new drainage networks, fused joints should normally be specified. Consult U-M Design Manager. Fused joints are generally less prone to developing leaks, but may be more expensive. All sink P-traps shall be of the same material as the waste pipe, and include mechanical fittings for ease of maintenance.

Underground piping shall be polypropylene, Schedule 80. Joints shall be fused type. Consult U-M Design Manager. Double walled underground piping is not generally required.

Alternate piping material shall be considered on a case-by-case basis where high temperature waste or other factors may be present. High silicon cast iron may be considered if the application warrants the added expense. Glass piping may be considered where high temperature waste is present.

High Purity Water Piping

Design piping system to meet project specific requirements. Some applications can use PVC piping (humidifiers), while others require polypropylene (most labs). Consult U-M Design Guideline 220020 – High Purity Water Systems for detailed requirements.

Vacuum Piping

Provide a plugged cross at all turns greater than 45 degrees, slope in the direction of flow and provide hose end drain valves at all low points for cleaning the system.

Chilled Water Piping

Large underground piping should generally be uninsulated ductile iron (Class 52 with Polyethylene wrap). For small piping, consider alternate materials and need for insulation.

Hot Water Heating Piping

Underground piping shall be installed using a preinsulated piping system. Carrier pipe shall match above ground piping. Jacket pipe shall be minimum 10 gauge steel, with butt welded fittings, and a fiberglass reinforced urethane elastomeric coating. Refer to section 220719 for insulation requirements.

(Steam) Condensate Piping

Underground condensate (from steam) piping shall be schedule 80 black steel with extra heavy fittings in a preinsulated system as described for underground hot water heating piping. Condensate piping shall not be run in common jacket pipe with other carrier pipes, unless specifically approved by U-M Design Manager and Utilities Department. Generally, two underground condensate lines are installed – one spare for future use.

Condenser Water Piping

U-M is presently considering non-ferrous (stainless steel, fiberglass, ABS) piping alternatives for improved water quality. Preliminary analysis indicates that non-ferrous piping may be justifiable, especially in applications where the cooling tower is drained seasonally, and where piping is not heat traced and insulated. Schedule 10 stainless steel condenser water piping has been used on some projects. Consult U-M Design Manager.

Underground condenser water piping shall be ductile iron.

Steam Piping

Underground steam piping up to 125 psig shall be Schedule 40 black steel with butt welded fittings, in a pre-insulated system as described for underground hot water heating piping.

Civil Pipe Material Requirements

Generally, underground piping 5 feet or more from building exterior walls is considered to be “Civil Piping”. The following piping materials apply to Civil piping only, and may indicate that a change in pipe material takes place at this point. Refer to Tab 2 - Sitework for additional requirements.

Storm Sewer

Shall be reinforced concrete pipe (RCP), ASTM C-76, Class IV, with rubber gasketed joints, ASTM C-443, or High Density Polyethylene with rubber gasketed joints. For small projects with piping limited to 6” and 8”, Schedule 80 PVC pipe may be used.

Sanitary Sewer

Shall be extra strength vitrified clay pipe (VCP) with O-ring joints. Sewers 15” and larger shall be reinforced concrete pipe (RCP), ASTM C-76, Class IV, with rubber gasketed joints, ASTM C-443

City Water Mains (for domestic water and fire protection)

Shall be Ductile Iron Class 52 with Polyethylene wrap.

Under Drainage Tubing

Shall be corrugated polyethylene tubing (AASHTO M 252) or corrugated polyvinylchloride tubing (ASTM F 800, with holes conforming to (AASHTO M 252)

Lawn Sprinkler Piping

Coordinate irrigation system design (including sizing water main, backflow preventer, and water meter) and installation with the University Landscape Architects Office and the U-M Plumbing shop, via the U-M Design Manager.

Pipe Hangers and Supports

Refer to U-M Standard Details, U-M Master Specification 230000 for additional hanger and support requirements previously addressed in Design Guideline Section 221113. Refer to Design Guideline Section 230000 for building attachment requirements previously included in this section.

Prior to beginning design, A/E shall review building design and construction and design suitable building attachment and pipe support and anchoring system, verifying that the existing building structure can support new piping loads.

The A/E shall include the following in piping designs:

- Pipe hanger details, including components, hanger spacing.
- Pipe hanger systems that accounts for thermal expansion of piping.
- Details of building attachments, including clarifying when support of piping from concrete slab using expansion anchors is acceptable. "C" type clamp hangers are acceptable for fire protection piping and all piping 2" and smaller when retaining clips are used.
- For large piping or where the design otherwise impacts the integrity of the building structure, indicate locations of all pipe hangers.
- For existing buildings with concrete floors, determine the extent to which vertical drill-in or similar type inserts can be used, and delineate any limitations regarding their use in the specifications. Many older buildings may not have sufficient floor thickness or integrity to allow the use of such inserts.
- Indicate locations and details of pipe anchors, guides and expansion joints or bends.

A/E shall include the following in the Project OPR/BOD document:

- Pipe expansion and stress calculations for hot pipes (120°F and above), 6" and larger. Show compliance with ANSI piping codes.

Large piping and equipment shall be independently supported from building structure, not from roof decks, etc. All piping shall be directly supported from the building, not from other piping, ductwork or equipment.

Dissimilar metal-to-metal contact between pipe and hanger is prohibited. Specify isolators, such as plastic coated hangers for copper pipe, to avoid dissimilar metal-to-metal contact between pipe and hanger.

Hangers for piping that lacks rigidity, such as polypropylene pipe, shall be spaced, as a minimum, as recommended by the manufacturer or preferably, with a continuous support. Since the spacing is typically much closer than for other piping materials, the designer must pay close attention to the implications on the design.

For cold piping systems, design piping hangers to retain integrity of vapor barriers. Specify cal-sil or similar pre-formed inserts and insulation shields for all piping 4" to 12" requiring a vapor barrier (wood blocking is not acceptable). Insulation shields are acceptable for piping 3" and below.

Design for Thermal Expansion:

Account for thermal expansion when designing pipe hangers and supports. Where space allows, expansion bends fabricated from standard piping are preferred over expansion joints.

For Expansion Design Requirements for steam in tunnels, see U-M Design Guideline SBA-H.

For steam tunnels, on low pressure steam (LPS), externally pressurized bellows type expansion joint shall be used. For low pressure condensate (LPC), use externally pressurized bellows type expansion joint or equal expansion bellows type expansion joint. For domestic hot water

(DHW), use equal expansion type bellows joints with all Stainless steel construction (no carbon steel on wetted parts). Refer to U-M Master Specification 220516 – Pipe Expansion Joints.

Pipe Hanger Submittals

A/E shall require that the Contractor submit the following for A/E review and approval:

- Type and model for all manufactured pipe support components, including building attachments, hangers, insulation saddles and shields, expansion joints, anchors.
- Locations of anchors, expansion bends and joints.
- Locations of building attachments where deemed necessary by A/E.
- Details and supporting calculation of additional supports.

A/E shall review contractor's hanger support shop drawings and details to verify that unacceptable pipe movement during all phases of operation of the system (start-up, sudden gpm changes, or shutdown) will not occur.

Pipe Hanger Shields and Preinsulated Pipe Supports

Pipe shields and preinsulated pipe supports shall be used to protect piping insulation and vapor barrier (for cold piping) as described below.

- Horizontal Cold Piping (CHWS/R, CW) sizes 2" and less:
Provide galvanized insulation protection shields under 180 degrees of piping, between hangers and pipe insulation.
- Horizontal Cold Piping (CHWS/R, CW) sizes 2 1/2 and over:
Provide 360 degree preinsulated welded pipe shields between piping and hanger.
- For all Cold Piping Vertical Risers:
Provide preinsulated riser clamps.
- For Hot Piping:
Account for thermal expansion when designing pipe supports and shields. Where suitable install hangers directly on the pipe and bury hanger in insulation. Where necessary, install pipe saddle on pipe, preinsulated pipe shield or galvanized insulation protection shield.

Pipe Penetrations and Sleeves

Provide pipe sleeves where required, including the following locations:

- Where required by code
- Where required as part of rated penetration, to maintain fire and smoke rating
- To support vertical piping (to support riser clamps).
- Where required to maintain water seal and prevent water penetration.
- Where pipe movement is anticipated (especially due to thermal expansion) at the penetration.

Fire Protection Piping, Compressed Air and other uninsulated piping: Sleeves are generally not required, unless required to maintain integrity of rated walls.

Chilled Water and Cold Water: Sleeves are generally required for all piping 2" and larger penetrating walls and floors.

Steam, Condensate, Heating Hot Water, and other hot insulated piping: Sleeves are required for all piping in walls and floors.

For underground exterior wall penetrations, piping penetrations must be watertight. For new construction, provide cast-in-place pipe sleeve with integral water-stop, oversized for use of linkseal between piping and sleeve. In existing concrete, where concrete can be core drilled and properly sealed with a linkseal, a sleeve may not be required.

For renovation work with existing concrete floors or for new floors where cast-in-place sleeves were not installed, pipes penetrating above grade floors typically require "double core" sleeves, especially in areas where floors are likely to get wet, and where water leaks to floors below would be disruptive to operations. Piping in stairwells does not require floor sleeves.

Include appropriate, project specific penetration and sleeve details for all conditions. Refer to U-M details, and customize as required.

Pipe Pressure Testing Requirements

Include pressure testing requirements in the project specifications or on the project drawings. U-M Standard Detail 221113 – Basic Piping Materials and Methods indicates typical pressure testing requirements and may be used provided it is revised to reflect project specific requirements.

For each system pressure tested, require that a test report be provided using owner furnished forms, certifying that the system was satisfactorily tested and passed.

Flushing and Cleaning of Piping Systems

At minimum, the A/E shall include the flushing and cleaning requirements found in Part 3 of U-M Master Specification 221113 – Basic Piping Materials and Methods. Refer to the spec. editors notes in U-M Master Specification 221113 for additional information.

Dye Testing Requirements for Storm and Sanitary Piping

Dye testing is required on most new connections to new and existing storm and sanitary waste piping. Refer to Master Specification Section 221113 (including hidden notes) and OSEH Dye Testing Guidelines for Storm Water & Sanitary Systems.

Where practical, dye testing of underground piping should be done during design phase to validate that the design is in compliance with effluent discharge codes and regulatory requirements. Special attention should be paid to mechanical room floor drains and cooling

tower overflow drains, both of which are now required to be routed to sanitary waste. Testing may also require services of the U-M Plumbing Shop. Coordinate with U-M Design Manager.

Require construction phase dye testing by the contractor, after final connection is made, and before system is put into service. See the U-M Master Specification Section 221113 for additional guidance. To facilitate efficient and effective testing, indicate location of appropriate validation points on plans. This is typically the first manhole outside the building.



BASIC MECHANICAL REQUIREMENTS

General

Within the scope defined by the Program Documents, perform the project mechanical design work and produce the project mechanical construction documents in accordance with these Design Guidelines.

Related Sections

[SID-F - Codes and Regulatory Agencies](#)

Design Requirements - Codes and Standards

In addition to the **Codes** listed in section "Codes and Regulatory Agencies", the following **Standards** apply to mechanical projects. Use most current update. Where these **Standards** conflict with related **Codes**, **Code** shall take precedence.

- State of Michigan Fire Marshal Division, "Fire Damper Clarification".
- NFPA 101, "Safety to Life from Fire in Buildings and Structures".
- NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- Factory Mutual loss prevention data sheets.
- NFPA 13 "Installation of Sprinkler Systems".
- ANSI/ASHRAE/IES 90A Energy Standard.
- ANSI/ASHRAE/IES 100.5 Energy Standard.
- AABC National Standards for Total System Balance.
- ACGIH Industrial Ventilation.
- ASHRAE Handbook - Fundamentals, Equipment, HVAC Systems and Applications, Refrigeration.
- ASHRAE 62 Ventilation for Acceptable Indoor Air Quality.
- SMACNA - HVAC Testing, Adjusting and Balancing.
- NEBB - Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems.
- AWS D 9.1 - Welding of Sheet Metal.
- AMCA - Standards, Definitions, Terms and Test Codes for Louvers, Dampers and Shutters.
- NFPA 14 - Standpipe and Hose Systems.
- Michigan Occupational Safety and Health Act.

The enforcing authority is the University of Michigan.

Design Requirements - Future Growth, Spare Capacity, Existing Conditions

When designing new installations, consider providing spare capacity for future growth. When designing renovations to existing installations, verify the existence of spare capacity before utilizing it for the new loads. Also field verify existing conditions - do not assume that existing design drawings are complete or accurate.

Design Requirements - Maintenance Accessibility

Locate equipment requiring maintenance so that it is easily accessible. Avoid installations that require the use of lifts or scaffolding, or the removal of other equipment for routine maintenance. Provide access doors to all maintainable equipment located behind walls or above permanent ceilings.

Preferred Manufacturers List

The University (Facilities Planning and Design) maintains a "Mechanical Trades Preferred Manufacturers List" (PML). This list is updated regularly, generally in February and August. The A/E shall use this list in developing construction document specifications. Obtain a current copy from the University Project Coordinator. This list is also available through this website.

Where specific manufacturers are specified in U-M AEC specifications other manufacturers listed in the PML may be added provided a model with similar quality exists, subject to the approval of the U-M Design Manager.

Demolition Requirements

To maximum extent feasible, remove abandoned branch piping and ductwork back to risers/mains. Remove abandoned conduit and equipment.

The A/E must caution the Contractor that all shutdowns of systems serving occupied spaces outside the area of this project shall be absolutely minimized. This will require that, for example, branch duct runs shall be capped and sealed at the time of partial duct removal to allow use of the remaining duct system until the new ducts are installed. Temporarily rebalance if pressure relationships are critical. Ducts cannot be left open unless the entire system can be taken out of service throughout the full construction period.

Other systems which are presently operating that are to be abandoned, as well as those previously abandoned should be removed.

Operating and Maintenance Instruction Manuals

Four sets of **job specific** operating and maintenance (O&M) manuals shall be provided for each project. These manuals shall be collected in indexed three ring binders and contain manufacturer's operating and maintenance literature for every equipment item furnished for the project. Typical wiring or piping schematics are NOT acceptable; they must reflect the actual furnished equipment, including all options and interfaces with other equipment or

systems. O&M manuals shall include a steam trap inventory with individual trap identification, service, manufacturer and model.

A single copy of each **job specific** O&M manual shall be submitted immediately after all shop drawings have been approved. This copy will be reviewed by the A/E and University personnel, then sent back to the contractor for corrections. All four corrected copies must be received by the University two weeks prior to any scheduled training.

Drawing Requirements

The amount of outdoor air for each air handling system must be shown on the equipment schedules.

Prepare the following mechanical drawings (as applicable to the project) for use during construction:

- Demolition plans and details
- Plumbing plans, including underground (within 5 feet of the building)
- Piping plans and details, including all utility meter locations
- HVAC plans and details
- Mechanical room layouts showing free space required for maintenance
- Plumbing, piping (including specialty gases) and HVAC (SA, RA, EA) risers

The drawing shall be of high quality in accordance with the Construction Documents Section of the Special Instructions to Designers.

Shop Drawings and Air/Water Test and Balance Reports

The University will retain three copies of all such submittals and the A/E will retain one copy. Therefore, the Contractor will be required to submit four copies of all such submittals plus however many copies he wishes to retain.

Access for Maintenance Operations

Add access hatches as required to service valves, dampers, coils, VAV boxes and mechanical equipment.

Structural Supports

All supports for piping and equipment shall be selected so that deflection caused by the load does not exceed 1/240th of the span.

Dust Protection

All mechanical and electrical equipment shall be protected from construction dust. Before start-up, motors must be covered or enclosed in a dust free manner. After start-up the

surrounding area must be kept as dust free as possible by regular and frequent cleaning, dust control compound etc.



HVAC DESIGN

Scope

General requirements for HVAC design including zoning, design weather data, temperature and humidity, acoustics, and ventilation.

Related Sections

U-M Design Guideline Sections:

[SID-B Owner's Project Requirements and Basis of Design Documents](#)

Definitions

Zone: A group of one or more spaces having a single thermostatic control.

HVAC Zoning

Normal zoning for offices and office like spaces at the University of Michigan shall be:

- Exterior Spaces: Two spaces per thermostatic control zone.
- Interior Spaces: Four spaces per thermostatic control zone.

However, zoning for these as well as all other space types shall be configured to assure that the required temperature and humidity control ranges are attained.

Conference rooms and spaces on corner building exposures should be on a separate zone.

When establishing zones the following shall be considered:

- Similarity of sensible and latent loads
- Occupancy
- Occupant transiency
- Space type, e.g. lab, open office, class room, etc.
- Exterior exposure location/number of exterior exposures
- Allowable temperature and humidity range
- Impact of zoning on potential energy conservation opportunities
- Energy code requirements
- LEED credits

This is not a comprehensive list. The A/E shall determine the considerations specific to the project and design the zoning accordingly.

Mechanical System Design Criteria

Determine project specific temperature, humidity, air change rate, cleanliness, acoustic, and other design criteria for each space by consulting with the User and the U-M Design Manager. Indoor and outdoor design criteria shall be stated in the Owner's Project Requirements/Basis of Design Documents (OPR/BOD). When no OPR/BOD is planned, indicate this information on the drawings (first sheet of the applicable section).

Outdoor Air Design Conditions (Summer: ASHRAE Detroit Willow Run airport data)

HVAC Winter: Negative 10F & 0% RH

HVAC Summer: 87.9F DB / 72.7F WB (ASHRAE 1%) for lab/research areas
84.5F DB / 70.9F WB (ASHRAE 2.0%) for office/classrooms

Cooling Towers: 95F DB / 78F WB

Dehumidification (critical spaces): Select 0.4% or 1% ASHRAE dehumidification data in consultation with the U-M Design Manager.

Typical Indoor Design Conditions - Acoustics

Class/Meeting	rooms:	NC/RC	30
Offices/Labs:		NC/RC	40
Labs with Fume Hoods:	NC/RC 50		

Indoor Air Temperature and Humidity

Design projects to produce acceptable indoor comfort. Consider the design application, all HVAC loads, as well as initial and operating costs of various alternatives. To minimize cold drafts, provide new and existing buildings with perimeter radiation heat unless this requirement is specifically waived by the University Design Manager. At the same time, consider optimization of building skin to allow perimeter heat to be eliminated without compromising comfort.

Humidification is generally required, except where specifically waived by the University Design Manager. Criteria must be carefully selected to balance human comfort with building skin integrity. General winter humidification criteria: 30% RH. Central power plant steam contains amines; when used for direct injection humidification this may be objectionable in some cases. For office and other areas with relatively low outside air requirements a "clean steam" humidification system may be appropriate. Clean steam typically consists of a steam to steam heat exchanger with RO make-up water. In lab areas and other high outside air environments, direct steam is often acceptable. Consult with the User and the University Design Manager early in the design phase to clarify project specific humidification requirements.

Typical Space Design Criteria

(These are the minimum performance levels the HVAC system shall be designed to achieve when the User or the U-M Design Manager is unable to provide specific requirements):

Office/Classrooms/Labs

Summer: 75F maximum dbt, 60% maximum RH

Winter: 72F minimum dbt, 30 % minimum RH

Typical Space Set Points

The following set points shall be indicated on the project control drawings when the User or the U-M Design Manager is unable to provide specific requirements for a space:

Office/ Classrooms/Labs:

Heating Setpoint: 71°F

Cooling Setpoint: 76°F

Throttling Range (DDC controls): minus 1°F heating, +1°F cooling.

Dead Band (minimum): 5°F

Ventilation

Provide designs that comply with the Michigan Mechanical Code (MMC) and with the latest edition of ASHRAE 62.1 Ventilation for Acceptable Indoor Air Quality. However, the natural ventilation requirements of the MMC shall govern over the requirements found in ASHRAE 62.1. The natural ventilation approach shall typically be limited to dormitories.

For any air handling system exceeding 5000 CFM that has multiple recirculation paths, use the Appendix A approach of ASHRAE 62.1 to optimize the System Ventilation Efficiency to adjust the required system outdoor air rate to the point which provides the lowest over-all energy cost. This is most easily accomplished using energy modeling software such as Carrier Hourly Analysis Program.



FANS AND ACCESSORIES

Scope

Fans and accessories. Fan arrays.

Related Sections

U-M Design Guideline Sections:

[220514 Variable Speed Drives](#)

[230013 Air Handling Units](#)

U-M Master Specification Sections:

[233400 - Fans](#)

General

U-M Master Specification Section 233400 - Fans shall be used as the basis for fan specifications on all projects. The A/E shall edit the U-M fan specification to make it project specific. While many fan types are covered by this specification, not all fan types are included. Turn on hidden text and read all spec. editor's notes when editing the specification.

Direct drive fans are preferred for fans driven by variable frequency drives.

Limit belt driven fan speeds to approximately 1400 RPM.

Limit direct drive fan speeds to approximately 2700 RPM. However, it is strongly preferred that fan speeds not exceed 1800 RPM.

Forward curved fans shall not be specified except when air foil or backward inclined fans are unavailable, or when a forward curved fan provides significant performance advantages. Modular air handlers are often available with either forward curved or backward inclined/air foil fans. If backward/air foil type are available specify that type, except as qualified above.

For plenum fans, the impacts on fan performance from any inlet mounted back draft dampers shall be compensated for when selecting such fans. Backdraft dampers should be actuator driven.

Extended lube lines shall be specified where bearings are difficult to access or for units providing service to areas that might be compromised by opening an access door for bearing lubrication, e.g. clean room units, lab units with stringent temperature, pressure, or humidity controls, etc.

Fan Arrays

Fan arrays are not preferred except when space or redundancy requirements demand them. Each fan in an array requires a separate motor overload, and each fan should typically have a separate electrical disconnect. Refer to Design Guideline 220514 for additional requirements related to variable frequency drives. Typically additional air flow stations and controls are required. This all adds to complexity, cost, and maintenance. Fan arrays of more than 4 fans in particular are not preferred since they typically use more fan energy and do not save space when maintenance clearance requirements are considered. Therefore the A/E shall provide an analysis comparing the energy use, space savings, and any other benefit that results from various fan quantities, for any fan array system proposed to use more than 2 fans. This analysis shall include the impact of fan and motor efficiency differences between the various alternatives, as well as the cost for additional disconnects, fan motor overloads, air flow stations, controls, etc. .

Fan speeds in fan arrays should be limited to the range indicated for direct drive fans, above.

Each fan in a fan array should be equipped with its own variable frequency drive. Controlling multiple fans off the same VFD is discouraged and shall be approved by the U-M Design Manager. If multiple fans are controlled by a common VFD, provide a separate electrical disconnect for each fan. In such cases, early break contacts may be omitted from the individual fan disconnects.

Equipment Room Exhaust Fans

A single fan in the exhaust duct is preferred, provided the negative static pressure at the equipment room remains within reason. For rooms deep in the building, both supply and exhaust fans will be required.



AIR FILTERS

Scope

This Design Guideline covers air filters for general HVAC use. It does not pertain to clean rooms or other spaces requiring High Efficiency Particulate Air Filters, or filters in laboratory equipment such as bio-safety cabinets. It does not cover specialty filter requirements that may be required for a specific project.

Related Sections

U-M Design Guideline Sections:

[230013 - Air Handling Units](#)

U-M Master Specification Sections:

[234000 - HVAC Air Cleaning Devices](#)

General

Filters shall be specified using U-M master specification 234000 - HVAC Air Cleaning Devices. Edit this specification section to make it project specific. Turn on hidden text and read all spec. editor's notes when editing specifications.

Air filters shall be scheduled on the design drawings. Minimum schedule data shall include:

- Service
- Location
- Filter type (bag, pleated, etc.)
- MERV (Minimum Efficiency Rating Value)
- Dust spot efficiency
- Filter dimensions including depth
- Clean filter pressure drop
- Dirty filter pressure drop (1" w.g. typical)

For the typical air handler, specify filters and frames capable of a dirty filter pressure drop of 1" w.g. In all cases, size air handling (and exhaust) systems so that design air volumes can be delivered at the dirty filter pressure drop condition, not at some intermediate filter drop condition.

For filter efficiencies above 30%, bag filters shall be specified. Due to problems with disposal, box style filters shall not be used except in unusual circumstances, when approved by the Design Manager.

Roll type filters shall not be used.

Washable filters shall not be used.

Filters shall be designated as face mounted with the filter seals sealing against the upstream side of the filter frame. *Side slide filters shall only be used in unusual circumstances.*

For air handling equipment above 5000 CFM, always provide a prefilter and a secondary filter, located upstream of the first coil in the unit. This includes units equipped with final filters at or in their discharge.

Design filters so that the maximum air flow velocity across the filter does not exceed 500 FPM.

In all cases the AE's design must provide adequate access to allow changing filters. It shall not be necessary to remove fixed items, including ceiling grid, to change filters.

Filters and filter rack design should be based on the use of 24"x24" filters whenever possible. The use of 12"x24" filters to complete rack configurations is acceptable. If 24"x24" and 12"x24" modules are not possible, use industry standard filter sizes.

Filter Efficiency Guidelines

The below are guidelines only. Specific project requirements may mandate higher efficiency ratings.

Very small or non-critical air systems serving spaces less susceptible to dirt, e.g. mechanical rooms, may be designed with prefilters only.

Pre-filters shall be 2" deep, 30% efficient, MERV 8, pleated panel type. Provide pre-filters in front of any filter with a dust spot efficiency of 65% or greater.

Secondary filters for air handlers with a significant return air component shall be 65% dust spot efficient, MERV 11, bag type.

Secondary filters for continuous 100% outside air units shall be 95% efficient MERV 14, bag type.

Vivarium animal room filters used to protect exhaust Laboratory Terminal Airflow Units shall be ring panel type filters. These shall normally be mounted in the duct as opposed to on an exhaust grille face, and shall be equipped with a Magnahelic gauge.

Provide the manufacture's standard efficiency filters for packaged terminal air conditioners, fan coils, and similar small equipment. However, when this equipment exceeds 1000 CFM, specify 2" deep 30% efficient MERV 8 filters whenever possible.



AIR HANDLING UNITS

General

This section describes design requirements, types, and arrangements of air handlers required, sizing considerations, and minimum air handler construction features. Testing, temporary use, and training are also covered.

Related Sections

U-M Design Guideline Sections:

[230000 – Basic Mechanical Requirements](#)

[230011 – Fans and Accessories](#)

[230012 – Air Filters](#)

U-M Master Specification Sections:

[230900 – Mechanical Systems Controls](#)

[233400 – Fans](#)

[234000 – HVAC Air Cleaning Devices](#)

[237323 – Custom Air Handling Units](#)

[237324 – Semi-Custom Air Handling Units](#)

[238216 – Coils and Drain Pans](#)

Design Requirements

Air handlers shall be specified using the U-M master specifications: 237323 - Custom Air Handling Units, or 237324 – Semi-Custom Air Handling Units. Edit these specification sections to make them project specific. Note that when using these specifications the U-M related master specifications for fans (233400), filters (234000) and coils (238216) must be included since these components are not specified within the air handler specifications. Turn on hidden text and read all spec. editor's notes when editing specifications.

For all air handling equipment greater than 2000 CFM, the engineer shall provide a scaled elevation of the unit on the design drawings. This elevation shall indicate component arrangement and identify each unit component: dampers, access sections, doors (including door size), door windows, access panels, pre and final filter, coils, humidifiers, fans, blenders, eliminators, diffuser plates, lights, drain pans, flex connectors, and all significant accessories. Maximum height, width, and depth, as well as base rail height, shall also be indicated.

For all air handling equipment, the plan view drawings shall indicate the arrangement of each component, overall unit size, coil pull space, and access door swings. The plan views shall also indicate the unit's designation and the maximum unit CFM.

Units shall be labeled with sequential alpha-numeric designators. For retrofit designs, do not repeat the numerical designator of existing units; coordinate with U-M Utilities and Plant Engineering via the U-M Design Coordinator to determine the appropriate designator.

Designate adequate roof curb or housekeeping pad height to allow proper trapping of cooling coil drain pans. Provide a detail that indicates the trap height dimensions for every coil trap.

To avoid snow entrainment, limit air velocity through intake louvers to 300 FPM through the louver free area at outside air volumes that occur at 35°F or less (for example, this volume is the maximum supply air volume for 100% outside air units; for units with return, it is half the maximum supply air volume assuming 75°F return air and 35°F outside air being mixed to 55°F), and limit intake plenum velocities to 500 FPM in all directions. Slope the bottom of plenum/duct connections to the louver so that water drains out the louver.

Air Handling Unit Types

For the purposes of this guideline, semi-custom units are defined as air handlers for light to medium duty use, consisting of manufacturer's pre-engineered standard modules, with limited selections in terms of quality, features, and arrangement.

Semi-Custom units should normally be specified for applications such as offices, class rooms, and light duty lab applications (e.g. dry labs with very few or no fume hoods) where operation is generally limited to 5 days per week, 8-12 hrs/day. However for units greater than 20,000 CFM, the design should normally be based on custom units.

Custom units should normally be specified for large wet labs and dry labs, 100% outside air applications (except mechanical or electrical room ventilation), vivaria, clean rooms, 24/7 applications, and other medium to heavy duty applications.

Contact the U-M Design Coordinator early in the SD phase to establish custom versus semi-custom AHU locations.

Roof top units are not preferred and shall not be used except when approved by the U-M Design Coordinator.

Arrangement

Fan Arrangement: Draw through units are normally preferred, except for exterior units.

Returns fan configurations shall be used. Configurations using exhaust/relief fans or no return fan should be avoided and shall be used only when dictated by unusual circumstances.

Units shall be arranged to allow proper access for routine maintenance of all components. At minimum, access shall be provided for the replacement of the following components: Filters, coils, fan shafts, bearings; without unit disassembly or partial demolition of the unit or adjacencies.

Sizing

For applications where load growth is likely to occur over the life of the unit, e.g. lab buildings, size all air handler components (fans, coils, filters, etc.) with additional capacity for future use. Determine the appropriate additional capacity in consultation with the U-M Design Coordinator.

When sizing units, assume 5% duct leakage and 1°F temperature heat gain in supply ducts.

Fans shall be sized assuming dirty filter pressure drops, which are typically 1" w.g. static pressure drop across the pre filters and 1" w.g. static pressure drop across the final filters.

Construction

Unit Casing

Solid inner walls are preferred whenever possible. Perforated walls should only be utilized when external sound attenuators or other means are found to be ineffective in meeting the required noise criteria.

The minimum wall thickness for semi-custom units shall be 2". The minimum wall thickness for custom units with fiberglass insulation shall be 4", except 2" foam insulated panels are permitted if such panels match the performance of 4" thick fiberglass insulated panels. See the U-M Master Specification section 15854 for more details.

For roof top mounted units, consult the Architect and the U-M Design Manager to determine if a custom paint color or screening is required.

For units above 10,000 CFM, each access section shall be illuminated. See the U-M Master Specifications for details.

Drain Pans

Drain pans shall be designated as above floor type. Avoid floor recessed drain pans whenever possible due to the difficulty of replacement.

Drain pans shall be stainless steel. Plastic drain pans are acceptable in units of less than 2000 CFM.

Access Sections

Access sections shall be provided to allow up and down stream access to every unit component. For example, an access module shall be provided between each heating coil and cooling coil section; both the air entering and air leaving side of each coil shall be visible for inspection. The designer must accommodate these access sections when fitting units into the available space.

For large custom and semi-custom units (> 20,000 CFM), in particular those with a large outside air component, consider (with the U-M Design Coordinator) providing an access section between the pre and final filters of adequate size to allow the final filters to be replaced from the upstream side without removing the pre-filters. As an alternative to the above, a hinged pre-filter section may be specified. For hinged pre-filter configurations, also specify a gap between the pre-filter and final filter frames to allow a static pressure tap to be installed so that a separate pressure drop reading may be taken across the pre and final filter banks.

Access Doors

Hinged access doors are required in each access section.

Minimum door widths are specified in the U-M AHU Master Specifications. For semi-custom units, doors shall be a minimum 18" wide, but 24" width is strongly preferred. Widths narrower than 18" should be avoided and are unacceptable for sections requiring personnel (vs. inspection/arm reach only) access. For custom units, minimum door width shall be 24". In all cases, provide doors that are the full height of the unit, maximum 6' high.

Windows shall be provided in all access doors on units greater than 5000 CFM, and for all air handlers providing service to areas that might be compromised by opening an access door for inspection, e.g. clean room units, lab units with stringent temperature, pressure, or humidity control, etc.

Mixing Box Section/Air Blenders

The use of air blenders is strongly discouraged since U-M's experience is that such devices are ineffective in preventing stratification problems, leading to frequent nuisance freeze stat trips or more severe problems. Instead, arrange outside air and return ducts so that after combining, at least two directional changes occur prior to entering the air handler proper, or utilize blow through or other fan arrangements that completely eliminate such stratification problems. Use air blending devices only as a last resort and only with the permission of the U-M Design Manager.

When used, air blending units should be factory fabricated and should consist of fixed blades capable of providing a mixed air temperature within 6°F of the theoretical mixed air temperature. In a variable air volume AHU, this 6°F maximum deviation should apply throughout the CFM range specified. The devices should be sized to provide a maximum pressure drop of 0.15 inches water, with a stratification range not exceeding +/- 6° from the mean temperature. The A/E should lay out the AHU to provide a plenum sized for a minimum of 1/2 blender diameter upstream between return air duct and blender, and 3 blender diameters downstream between the blender and the first air flow obstruction (filter, coil, etc.).

Coils and Face/Bypass Modules

The maximum face velocity for cooling coils in both custom and semi-custom units shall be limited to 450 FPM. This face velocity shall be based on the actual coil face area sans any safing around the coil.

Maximum face velocities shall be based on any future capacity allowance for the AHU.

For units 10,000 CFM or greater, coil tracks and individual coil access panels shall be specified. See the U-M AHU Master Specifications for further details.

Coils shall have a maximum of six rows, and maximum fin spacing of 10 FPI. When these criteria can not be met, provide two coils piped in a series arrangement.

When multiple coils are stacked vertically, each coil in the stack shall be equipped with a balancing valve (circuit setter).

For 100% outside air units, or units with a large outside air component, “run-around” pumped hot water heating coils are preferred in lieu of steam coils (include redundant pumps for critical applications), for preheating applications. If preheat steam coils are used, multiple staged on/off steam coils shall be used, or a face/bypass arrangement may be used. For face/bypass arrangements, internal bypass or “Wing” coils shall not be utilized, rather an external coil bypass shall be utilized. The external bypass shall be routed to the downstream side of all unit coils (i.e. downstream of both the preheat coil and the cooling coil) and shall be sized to exert the same relative pressure drop on the fan as flow through the coils would exert.

Dampers

Damper construction is designated in U-M Master Specification 230900 - Mechanical Systems Controls. The U-M AHU Master Specifications also reference 230900 for damper construction. All air handler specifications shall utilize this damper specification for dampers provided by air handler manufacturers. This includes smoke and combination fire and smoke dampers that are provided by air handler manufacturers.

Filters

Units shall include pre-filters and final filters, except that very small, non-critical units or units serving spaces less susceptible to dirt, e.g. mechanical rooms, may include prefilters only.

Units serving substation rooms shall always be equipped with pre and final filters.

Pre-filters shall be 2” depth, 30% efficient, pleated panel type; final filters shall be bag type. Roll type filters shall not be used.

Filters shall be designated as face mounted with the filter seals sealing against the upstream side of the filter frame. Side slide filters shall only be used in unusual circumstances

Fans

Limit fans speeds to 1200-1400 RPM.

Forward curved fans shall not be specified except when air foil or backward inclined fans are not available, or when a forward curved fan provides significant performance advantages. semi-custom units are often available with either forward curved or backward inclined/air foil fans. Determine if backward/air foil type are available and always provide a design based on same when available, except as qualified above.

When plenum fans are utilized, specify a “guard cage” around the fan for safety. The impacts on fan performance of such cages as well as impacts from any inlet mounted back draft dampers shall be evaluated when selecting such fans. Assure proper up and downstream and side-to-side (relative to plenum walls and any adjacent fan(s) in the same plenum) clearances are maintained around plenum fans to prevent system effect problems or poor air distribution across upstream components.

Extended lube lines shall be specified where bearings are difficult to access or for air handlers providing service to areas that might be compromised by opening an access door for bearing lubrication, e.g. clean room units, lab units with stringent temperature, pressure, or humidity controls, etc.

Testing, Temporary Use, Training

Factory Testing

Custom units should normally be factory tested for air volume, pressure, leakage, and sound performance. Such factory testing is normally not required for semi-custom units, however it should be considered for air handlers that are not arranged in simple horizontal or vertical configurations, e.g. a fan section stacked on top of the coil sections. See the U-M AHU Master Specifications for further details.

Temporary Use/Field Testing

The U-M AHU Master Specifications contain specific criteria regarding the temporary use and field testing of air handling units.

Training

Training is not typically required on air handlers and should not be specified unless directed to do so by the U-M Design Coordinator. Consider need for training if units include direct expansion cooling.



PACKAGED ROOF TOP AIR CONDITIONING UNITS

Roof top air conditioning equipment (RTUs) is not preferred and shall be used only when absolutely necessary. Specify high quality roof top air conditioning units only. Refer to list of preferred manufacturers. Where necessary, use a continuous, sound attenuating curb when no access is required to the bottom of the equipment or support the equipment 24" above the roof (18" minimum) so that roof maintenance can be performed. Provide a catwalk for service access to routinely serviced components (such as control cabinets) that will be out of reach.

Typically, rooftop units controls should be U-M standard DDC. Direct expansion compressor and refrigeration controls may be manufacturer's standard.

Generally, units with return fans are preferred to units with exhaust fans.



FAN COIL UNITS AND BLOWER COIL UNITS

General

This section describes definitions, applications and design requirements for fan coil units and blower coil units.

For purposes of this section:

- Fan coil units (FCUs) refer to a variety of relatively small, unducted, floor or ceiling mounted units, used for cooling and/or heating the room in which they are located.
- Blower coil units (BCUs) refer to small to moderate-sized, ducted, floor or ceiling mounted units, used for cooling and/or heating the room in which they are located, and/or adjacent areas.

Fan coil units are one of the least preferred methods of providing air conditioning at the University. Blower coil units are generally preferred over FCUs, but less preferred than central HVAC systems.

Related Sections

U-M Master Specification Sections:

[230900 - Mechanical Systems Controls](#)

[238219 - Floor Mounted Fan Coil Units \(Un-ducted\)](#)

[238220 - Horizontal Fan Coil Units](#)

[238221 - Blower Coil Units](#)

Design Requirements

The U-M specifications listed above are typically recommended for use as the starting basis for fan coil and blower coil specifications on U-M projects. The A/E shall edit the specifications to make them project specific, in particular in the area of controls. The specification for floor mounted fan coils (238219) includes controls often used on U-M Housing projects, which may not be the appropriate choice for other projects. Turn on hidden text and read all spec. editor's notes when editing specifications.

For FCUs and BCUs, pay close attention to acoustic requirements of space served. FCUs and BCUs are generally not acceptable in classrooms, conference rooms.

Consider possible requirements for future additional capacity, and redundancy.

All FCUs and BCUs shall be individually scheduled and identified on the drawings.

Consider seasonal requirements and capabilities of chilled water, steam, and heating hot water.

Indicate maintenance requirements on drawings, for filter access. Account for access to all components requiring regular maintenance, including all valves.

For FCUs:

- Provide IAQ drain pan and code compliant method of over-flow protection
- Insulate cold piping inside and outside housing.
- Provide removable, replaceable filter.
- Provide multi-speed direct drive fans.
- Generally install floor mounted, non-recessed type. Low profile units are not acceptable due to difficulty in maintaining.
- Do not provide with integral outside air connection. Provide separate minimum ventilation air where required.

For BCUs:

- Provide IAQ drain pan, and code compliant method of over-flow protection
- Insulate cold piping inside and outside housing.
- Provide removable, replaceable filter: 2" pleated, minimum 30% efficiency.
- Provide belt drive fans with adjustable sheaves.
- Floor mounted, non-recessed type or ceiling mounted is acceptable, depending on project requirements, provided maintenance access requirements are met.
- Do not provide with integral outside air connection. Provide separate minimum ventilation air where required. If required, outside air for minimum ventilation load may be ducted to BCU return duct, provided outside air is filtered and includes an integral damper interlocked to BCU operation. BCUs should not be used for 100% economizer cooling.
- Use of BCUs should be limited to systems below 3,000 to 5,000 cfm, and should not be used in conjunction with VAV boxes.
- The generally preferred location of ceiling mounted BCUs is above corridors to allow service without disrupting the occupied space.

For FCU and BCU controls:

- See specification 230900 for control valve and actuator options.
- Do not provide factory-mounted, manufacturer DDC controls. Pneumatic or electronic thermostats, and manually controlled FCU fan speed are generally acceptable where there is little energy savings associated with reset controls. If networking or more complex control strategies are justifiable, provide U-M DDC controls.

Installation Requirements

Specify on the construction documents that the units must be installed to allow for maintenance of all serviceable components within the unit through without removing ducts, piping or other adjacent systems such as light fixtures.

Unions and isolation valves should be installed at all water service points to facilitate unit removal without disruption of service to the remainder of the building.



COMPUTER ROOM AIR CONDITIONING

General

This section addresses air conditioning requirements for computer rooms (including server rooms), and requirements for computer room units.

Related Sections

U-M Design Guideline Sections:

[230000 – Basic Mechanical Requirements](#)

U-M Master Specification Sections:

[230900 – Mechanical Systems Controls](#)

Design Requirements

Cooling Loads

Cooling loads vary widely in “computer rooms” throughout campus. The A/E shall work closely with the U-M Design Manager and end user to determine actual peak diversified load based on actual equipment. Consider future growth, redundancy requirements (see additional comments below in “Computer Room Unit Selection”), and seasonal changes, including seasonal limitations on the chilled water system, if used to provide primary source cooling. Clearly define all load and system design assumptions to U-M Design Manager, in a OPR/BOD document.

Temperature and Humidity Criteria

Clarify and document acceptable temperature and humidity criteria (summer and winter, including allowable range) with users and U-M Design Manager. The ASHRAE “recommended” temperature and humidity ranges found in the ASHRAE publication “*Thermal Guidelines for Data Processing Environments*” (most recent edition) should be the design criteria typically utilized for computer rooms. More stringent requirements shall be challenged and validated by the requesting parties because of the higher energy use that will result.

U-M generally discourages humidification for dedicated computer room systems. While humidification criteria is rarely as high as it had been in years past, extremely low RH (below 15%) may not be acceptable. Carefully analyze psychrometrics and alternatives (such as discharge air reset) before including computer room humidification. If humidification is required, steam generator-type humidifiers are preferred.

Source of Cooling

Outside air (air handler economizer cycles), in particular for larger computer rooms, is the preferred source of cooling when the application and infrastructure conditions permit. For critical applications, chilled water is the preferred source of cooling. Where chilled water is not available year-round, or where the chilled water system is prone to unscheduled shut-downs (including loss of chilled water during transition from free cooling to absorption cooling), combinations of chilled water primary and mechanical cooling secondary are recommended. For these applications, the refrigeration circuit may be air-cooled (equipped with low ambient refrigerant side controls) or glycol-cooled (with remote dry cooler).

The use of potable cold water for condenser cooling is not acceptable, except for very short-term temporary or emergency applications. These rare applications should be made only with the approval of the U-M Utilities Group through the U-M Design Manager.

Computer Room Unit Redundancy

While some computer rooms require full “n-1” redundancy (systems that can meet all loads with loss of the single largest component), most do not require this level of redundant capacity. Conversely, most systems will require some level of back-up cooling. For rooms with loads over 5 tons, multiple units should be installed, to offer some cooling capacity in the event of unit failure.

Controls and Alarms

Units that include mechanical cooling may include manufacturer’s standard electronic controls. Units with chilled water cooling only should be DDC controlled, integrated into U-M standard DDC system. In either case, unit failure and high temperature alarms should be integrated into U-M DDC BAS system.

Where chilled water is less reliable, where system does not provide full redundancy, and other select applications, consider using high temperature warning at 5F above setpoint to implement a graceful shut-down of non-essential equipment. In this way, users can improve reliability of essential systems. This strategy is not fully adopted by all computer room users.

For units located above a raised floor and other locations where deemed necessary, install a water sensor to detect an overflowing drain pan. Connect alarm to U-M DDC BAS system.

Emergency Power Impact

Computer rooms are not typically fed from emergency power, although many will have UPS systems. In the event that they are fed from emergency power, consider need to put computer room units and all required controls on emergency power. Central chilled water systems are not typically fed from emergency power.

Additional Computer Room Unit Features

A filter should be installed at the air-return opening.

The unit should be supplied with the optional integral fused disconnect switch, and all necessary controls to provide a completely functional unit.

Installation Requirements

At a minimum, chilled water coils should be piped with a 2-way control valve, isolation valves, and individually sized balancing valve (manual or automatic).

The unit should be supported from the concrete sub-floor slab with properly rated supports. Mounting units directly on raised floors is not be acceptable.



WINDOW AIR CONDITIONING UNITS

General

Window units are acceptable only if specifically approved by the University Project Coordinator.

Design Requirements

The A/E is responsible for field verifying the adequacy of the existing electrical service within the space to assure that the addition of this electrical load will not overload the circuit when all other existing equipment is operating at design capacity. If a new feed is required, it should be a part of this renovation project.

Equipment Requirements

Units which will be used to supply year-round ventilation should be equipped with an electric heating coil.

Units should be furnished with a window sleeve, approved by maintenance personnel.

Installation Requirements

Units should be mounted in the upper section of windows but not through-the-wall above the window (with ductwork to the occupied spaces).

Units should normally be mounted flush with the building exterior, projecting into the room. Deviations require approval by the Exterior Elements Design Review Committee.



DUCT SYSTEM DESIGN

Related Sections

U-M Design Guideline Sections:

[230030 - Laboratory Ventilation Design](#)

U-M Master Specification Sections:

[233100 - HVAC Ducts & Casings](#)

[233300 - Air Duct Accessories & RGDs](#)

General

A/E duct designs shall, at minimum, be in general compliance with SMACNA standards.

The A/E's duct specification shall state that duct construction shall, at minimum, meet SMACNA duct construction standards. The A/E's duct specification shall state that the Contractor shall provide their duct construction standards as their first shop drawing submittal so that the A/E can verify compliance with SMACNA standards.

Although typically SMACNA's HVAC Duct Construction Standards, Metal and Flexible, will apply, the A/E's spec. should also reference other standards if appropriate, e.g. SMACNA industrial duct standards.

The A/E shall provide a table that identifies the duct construction requirements for the project. At minimum the table shall include the following:

- Service/Location and/or System
e.g. Fume hood exhaust upstream of laboratory terminal units
- Duct Material
e.g. Stainless Steel (SS), Galvanized, Galvanized Plastic Coated Duct (PCD), etc.
- Pressure Classification
e.g. -2.0" w.g.

Design

Future Capacity: The amount of future air flow capacity the duct system shall be capable of handling, if any, shall be determined in consultation with the U-M Design Manager.

For duct pressure classifications greater than +/- 2" w.g., duct velocities shall not exceed 2500 FPM without the specific permission of the U-M Design Manager.

The amount of diversity assumed in the duct design shall be stated in the Design Intent Document.

Duct aspect ratios should be limited to a maximum of 4:1.

Round duct elbows constructed with centerline radius equal to or greater than 1-1/2 duct diameter shall be specified. Gored elbows are not permitted.

For rectangular duct, the AE shall design radiused rectangular elbows with r/W ratios of 1.00 or above, to the greatest extent possible. Squared elbows with turning vanes should be indicated when radiused elbows are impractical to fit .

Transition slopes should generally be 1/3 or less.

Indicate access panels on plans wherever ducts contain devices requiring maintenance or calibration, such as air flow stations, humidifiers, fire and smoke dampers, reheat coils, etc.

Indicate maintenance access by “dashing out” no-fly-zones in front of DDC terminal equipment controllers, laboratory air flow unit controllers, filters, and at other major duct mounted components.

Flexible duct shall be properly supported and shall not exceed 8' in length. The A/E should consider specifying flexible elbow duct supports (sample: www.flexflowelbow.com). Provide a detail demonstrating proper flex duct support.

Flexible duct connected to the inlet of terminal units shall be separated with a 24” long section of rigid metal duct located between the flex and the unit inlet. Provide a detail indicating this requirement.

Duct sound liner that is directly exposed to the air stream shall not to be used, except in exceptional circumstances and only with the permission of the U-M Design Manager. Utilize other duct design methods such as low velocities, directional changes, etc. for noise control. Double wall perforated duct with sound liner behind is permitted, provided a Tedlar or Mylar wrap is located between the sound liner and the perforated metal is specified. Sound attenuators shall be similarly specified or shall be packless type.

Materials/Construction

Galvanized duct shall be specified as G-90.

Fibrous glass duct shall not be used. Exception: This material may be used for “return boots” or short transfer ducts, i.e. for short segments of duct that are not hard connected to the duct system, used for the purpose of sound attenuation.

The A/Es specification shall define seal class as corresponding to the definitions found in SMACNA's HVAC Duct Construction Standards, Metal and Flexible. Specify the following seal classes:

- Ductwork rated for pressure of 2" w.c. or less: Class C (seal transverse joints only.)
- All other ductwork: Class A (seal all transverse joints, longitudinal seams, and duct wall penetrations).

Duct Sealant shall be specified as asbestos free.

Exhaust Duct

The A/E shall research the specific effluent being exhausted and shall specify duct materials and duct joining systems that will cost effectively provide long life and safe operation. Determine if a dedicated exhaust system is required or if multiple effluent sources can be safely exhausted through common exhaust ducts.

For the typical general research laboratory exhausting highly dilute, low corrosivity effluent, the following materials are often selected:

- Fume Hood Exhaust to Main Lateral: PCD
- Room General Exhaust (exhausting room only, to maintain required air change rates, *not* exhausting specific point sources): Galvanized Duct
- Autoclaves, Glass Washer/Glass Dryers, and similar moderately steam laden exhaust, from source to Main Lateral: stainless steel, welded longitudinal joints, duct sealant at transverse joints and duct wall penetrations, sloped down and back toward source to promote condensate drainage.
- Exhaust Mains/Laterals Above Lay-In/Accessible Ceilings, conveying fume hood, autoclave, or similar exhaust that is heavily diluted with room general exhaust: Galvanized duct.
- Exhaust Mains/Laterals/Risers in Shafts: PCD
- Exhaust Mains/Laterals/Risers exposed in penthouses and machine rooms: Galvanized Duct

The A/E' specification shall indicate that duct accessories and fasteners shall match the specified duct material, e.g. SS fasteners in SS duct, plastic coated components in PCD.

Tie rods shall not be permitted in exhaust duct running in shafts.

Exhaust with a heavy steam component, e.g. vivarium cage/rack washers, shall be specified as stainless steel duct with all seams, joints, and duct wall penetrations seal welded.

For positively pressurized sections of hazardous exhaust located inside buildings, including penthouses and machine rooms, specify that all duct seams, joints, and duct wall penetrations shall be seal welded. Locating positively pressurized hazardous exhaust in such locations is poor design practice. Obtain U-M Design Manager's permission first.

See U-M Design Guideline 230030 - Laboratory Ventilation for additional information on laboratory exhaust.

Installation

Duct leakage testing is required on all but very small U-M projects, and shall be specified as follows:

Leakage testing shall occur before duct is insulated or otherwise concealed.

Testing pressure shall match the duct's construction pressure class.

All ductwork with a pressure classification greater than 2" w.g. (positive and negative) or that is specified as "seal welded" shall be leak tested.

Ducts shall be leak tested per the procedures in SMACNA's HVAC Air Duct Leakage Test Manual.

Prior to testing, isolate any components that might be damaged by leak testing.

Duct leakage shall not exceed SMACNA Leakage Class 3.

Duct specified as seal welded shall demonstrate zero leakage.

Reseal and retest as required to achieve the specified leakage class.

Duct shall also pass an audible and touch test (2" from duct), conducted by the owner's representative, regardless of pressure class. All gross leaks and audible noise shall be eliminated.



TERMINAL AIRFLOW UNITS

Scope

Variable and constant volume non-fan powered terminal airflow units for general HVAC.

Related Sections

U-M Design Guideline Technical Sections:

[230030 Laboratory Ventilation Design](#)

U-M Master Specification:

[233600 - Air Terminal Units](#)

U-M Standard Details:

[15896001 – Supply Air TAU Clearance Detail](#)

General

This guideline covers conventional VAV/CAV terminal airflow units (TAU). It does not cover fan powered boxes. U-M master specification [233600 - Air Terminal Units](#) shall be used as the basis for the VAV/CAV box specification on all projects. The A/E shall edit the U-M specification to make it project specific. Turn on hidden text and read all spec. editors notes when editing the specification.

Commercial grade VAV/CAV boxes shall not be used in laboratories, vivariums, or other spaces requiring accurate room pressurization control. See [design guideline 230030 - Laboratory Ventilation Design](#) for the terminal units required for those areas.

Specification Requirements

VAV & CAV Boxes

Lining: dual density thermal/acoustic insulation with a cleanable foil liner is standard at U-M, and is specified in the [U-M master specification 233600](#).

Access panel: Access panels to allow up or downstream access to the reheat coil are not required.

Controls

VAV and CAV box control shall normally be by direct digital control (DDC) with electronic actuators.

For a standard DDC VAV/CAV boxes:

The box manufacturer shall provide the flow sensor and the damper.

The controls contractor shall furnish the following (all specified in U-M's master control specification 230900):

- Electronic damper motor actuator
- Electronic reheat coil valve actuator (if applicable)
- DDC controller enclosure (dust cover)

The box DDC controller, known as the "TEC" (terminal equipment controller) and the room temperature sensor, or "RTS" (thermostat), are provided by U-M to the controls contractor.

For atypical boxes (pressure/tracking control, etc.), carefully review the TEC section of U-M's master control specification 230900 for information about which trade provides specific components related to controls.

The controls contractor *may* elect to ship the controller, cover, and actuator(s) to the box manufacturer for mounting (or may choose to field mount the components), however this construction coordination issue does not need to be covered in the AE's specification provided U-M's master control specification 230900 is utilized on the project.

For the rare instances when a pneumatic controller is required, the *box manufacturer* shall provide a Krueter CSC-3011 controller, a controller dust cover, and a normally open damper with a damper operator. This information is specified in the U-M master specification [233600 - Air Terminal Units](#).

Design

On the plan views, for each terminal airflow unit, indicate the minimum and maximum CFM setting.

DDC controlled boxes require a minimum of 3' clearance in front of and the width of the DDC controller. DDC boxes shall be labeled with a unique identifier. Use U-M's **terminal airflow unit clearance detail**, [15896001 – Supply Air TAU Clearance Detail](#), which identifies clearance and labeling requirements. It is preferred the AE assign the unique identifier (per the detail's nomenclature system) for each box and indicate it on the design drawings.

Boxes should be located in corridors directly above suspended ceilings whenever possible, with unobstructed access for maintenance and removal.

Do not oversize boxes by more than 20%.

Attention shall be given to the take-off size and construction technique at the branch duct to assure sufficient supply air is available at actual branch duct static pressure. The A/E shall provide a take-off detail on the design drawings.



GRILLS, REGISTERS, DIFFUSERS AND AIR BALANCING ACCESSORIES

Design Requirements

Specify a 24 inches x 24 inches ceiling module whenever possible.

Size diffusers, registers and grills for a maximum space noise criteria of 30 in class and meeting rooms, and 40 elsewhere.

In VAV systems consider sizing to 80 percent design flow to prevent dumping at low flow.

Installation Requirements

All sub-main connections to main duct shall contain opposed blade balancing dampers. Branch connections serving individual outlets may not require dampers. However, volume control devices in or directly above diffusers should not be the primary means for system balancing.

Duct extractors and air flow equalizers should be specified as necessary to assure adequate flow and uniform air distribution.

Specify 2-way throw for corner installations and corridors. Specify 3-way throw at walls.

In rooms where heavier than air gases may be present locate one return air sidewall grill near floor level.

Locate supply diffusers and return/exhaust grills sufficiently distant to prevent short cycling. Distance between devices to be approximately 1 1/2 times the T-50 isovel throw. When this separation cannot be maintained, specify throw-reducing devices or specify a 3-way diffuser.



LABORATORY VENTILATION

Scope

Information for mechanical design engineers as well as architects/lab planners regarding laboratory ventilation design at U-M, including but not limited to the following:

- Equipment information (chemical fume hoods, chemical storage cabinets, BSCs, specialty hoods, and environmental rooms).
- Computational Fluid Dynamic and exhaust stack dispersion modeling requirements.
- Lab HVAC and exhaust design: guidance regarding lab minimum air change rates, duct materials, exhaust fan selection, system diversity, future capacity, etc.
- Vivarium requirements.
- Laboratory terminal units (venturi valves) and controls.
- Lab energy conservation.

Related Sections

U-M Design Guideline Sections:

[SBA-A Animal Facilities](#)

[SID-D Energy and Water Conservation](#)

[11610 Laboratory Fume Hoods](#)

[230900 Mechanical Systems Controls](#)

U-M Master Specification Sections:

[115313 Laboratory Chemical Fume Hoods](#)

[230593 Testing Adjusting, and Balancing](#)

[230910 Lab Air Flow Controls- DDC](#)

[230920 Laboratory Terminal Air Flow Units and Controls](#)

U-M Standard Details:

[Laboratory Terminal Air Flow Unit Sample Schedule](#)

[Laboratory Terminal Air Flow Unit Clearances](#)

General

Where this Design Guideline requires consultation with U-M Occupational Safety and Environmental Health Department (OESH), all such contacts shall be made via the U-M Design Manager.

Lab Equipment Parameters

Chemical Fume Hoods

General:

U-M Master Specification Section 115313 Laboratory Chemical Fume Hoods shall be used as the basis for chemical fume hood specification on all projects. 115313 must be edited to make it project specific.

U-M Master Specification Section 115313 describes fume hood types in terms of face velocity characteristics in a "Definitions" article. These definitions shall be used when specifying fume hoods and when designing fume hood exhaust systems at the University of Michigan. Fume hood air volume requirements depend upon the particular hood type being used, therefore the mechanical designer should carefully review the hood definitions section of 115313. 115313 also describes performance requirements for Reduced Face Velocity (RFV) hoods. Extensive spec editors notes are included in 11610 to assist the A/E. Be sure to turn on hidden text and read those notes.

Multiple fume hood types may be included on a given project. Clearly delineate on the mechanical drawings the air balance and fume hood monitor alarm settings for each hood type. See "Laboratory Terminal Airflow Units (LTAU) and LTAU Control", below.

The required exhaust flow (CFM), static pressure, and hood opening area (sq. ft.) vary by fume hood manufacturer. Refer to manufacturer's data and then size duct, laboratory terminal airflow units (LTAU), and fans to accommodate the manufacturer with the worst case (highest air flow and pressure drop) requirements. Provide the hood basis of design (manufacturer and model) on the mechanical design documents.

For vertical opening sashes, U-M requires sash stops be provided to restrict normal sash operation to no higher than 14" above the work surface, NOT the typical 18". Note that some Reduced Face Velocity fume hoods incorporate an air foil mounted above the hood's working surface. U-M spec section 115313 requires that the sash stop location be adjusted proportionally upward to account for air foils mounted more than 2" above the hood's working surface. The resulting higher sash stop location will result in a somewhat larger fume hood air volume requirement. This should be accounted for in the mechanical design.

Assure the TAB specification requires that the air balancer adjust the LTAUs to the air volume required for the particular manufacturer's hood that is installed. U-M's TAB specification 15990 includes this requirement.

U-M projects use standard chemical fume hoods that operate at an average face velocity of 100 FPM, and Reduced Face Velocity (RFV) fume hoods that operate at an average face velocity of 70 FPM. Refer to the "Design Fundamentals" section of this design guideline for exhaust system sizing requirements for the various hood types.

Constant volume hoods of any type are not safe with combination sash arrangements because correct face velocity can't be assured as the horizontal sash is adjusted. If combination sashes are required, Restricted Bypass VAV hoods shall be used with the corresponding VAV type lab terminal air flow unit control.

Requirements for Floor Mounted Hoods:

- Due to the wide variation of sash configurations available on these type hoods, floor mounted hoods shall be Restricted Bypass VAV hoods.
- Sash stops shall be supplied for every section of vertical sash, set to stop the sash at 14" above the sash's closed position

Fume Hood Monitor:

Fume hood monitors are provided by the lab air flow controls contractor, NOT the hood manufacturer. U-M specification 230910 and 230920 include specifications for fume hood monitors.

Fume Hoods in Explosion Proof Rooms

Since typical VAV controls are not explosion proof, constant volume hoods are recommended in explosion proof rooms.

Mount fume hood controls and alarm monitors outside of explosion proof rooms. Mount an explosion proof audible and visual low exhaust flow alarm indicator inside the room, triggered by the fume hood alarm monitor.

Laboratory Fume Hoods for use with Radioactive Materials (Isotope Hoods)

Although a special fume hood is generally required for use with radioactive materials, verify the need for special filtration, or a direct exhaust duct route to the outside, with U-M OSEH. Filtration and direct exhaust are not typically required.

In all cases, delineate space for a future filter box directly above radioisotope hoods.

Solvent and Corrosive Storage Cabinets

Chemicals shall not be stored within fume hoods. Where a storage space for chemicals is required, a storage cabinet below the fume hood may be provided.

Corrosive storage cabinets shall be ventilated at a rate of 2 CFM exhaust per square foot of cabinet footprint. Do not duct into the fume hood bench top. Instead run a separate exhaust from the cabinet up to the exhaust duct. Connect cabinet exhausts to constant volume (CV) Laboratory Terminal Airflow Units (LTAUs). This could be a CV LTAU serving a CV hood, other nearby CV LTAUs (serving snorkels, for example), or, gang multiple cabinet exhausts

on to a dedicated CV LTAU. Normally exhaust connections for cabinets should consist of a 2 inch polypropylene vent pipe equipped with a non-corrosive ball valve for balancing.

Solvent storage cabinets shall not normally be ventilated. If the lab occupant requests solvent storage cabinets be ventilated, obtain approval from U-M OSEH before doing so.

Biological Safety Cabinets (BSC) and Other Specialty Cabinets and Hybrid Hoods

Selection of the type, size, class, and manufacturers of BSCs and special “hybrid” hoods shall be made by the researcher and the U-M OSEH representative, in coordination with the Architect/Lab Planner/Mechanical Engineer.

If exhaust connection is required to a BSC, do not assume a direct connection is required since more often the BSC type will allow an indirect, hood mfg. provided, thimble (canopy) connection. Verify the BSC type and the corresponding exhaust connection required, direct or thimble connect, with U-M OSEH.

Many specialty cabinets and hybrid hoods (which often filter downflow supply air) require higher than typical exhaust flow rates (i.e. rates higher than would be suggested based on hood face area) or have high static pressure drop. Always consult the manufacturer’s product manuals and design accordingly.

Environmental (Cold) Rooms

Ventilation air is required in all environmental rooms where work with volatile chemicals, compressed gasses, or continuous work activity is planned. Ventilate at 6 air changes per hour or as required by code, whichever is higher.

Ventilated environmental rooms typically require desiccant dryers to avoid excess defrost cycle times. Thus, in addition to a ventilation supply and exhaust air connection to the room, the mechanical engineer will need to provide an exhaust connection for the removal of hot, moist air rejected from the desiccant unit.

Where multiple environmental rooms are located in close proximity to one another, consider ganging the rooms on common CV LTAUs, to provide the required supply and exhaust air.

Perchloric Acid Fume Hood Systems

Refer to Appendix B of this Design Guideline.

Lab Room Airflow Modeling

Computational Fluid Dynamic (CFD) studies are typically required when multiple hoods are located near each other and within the same room, unless this requirement is waived by the U-M Design Manager.

New lab buildings with “typical” fume hood alcoves or lab modules shall have CFD modeling done for each module type. CFDs shall demonstrate hood capture effectiveness, optimize air-change-rates (ACH), and evaluate supply outlet and exhaust inlet locations.

CFD Studies shall be considered for other unique air flow arrangements where proper ventilation, air conditioning, or exhaust are considered critical.

HVAC and Exhaust Systems Design

Exhaust Dispersion Assessments

Dispersion studies ensure proper, safe, dilution of exhaust emissions. Dispersion studies shall be done by qualified firms that have a minimum of 5 years of experience performing such studies.

All new lab buildings shall have a comprehensive dispersion study performed.

All critical exhaust sources shall have a dispersion study.

Renovation projects with exhaust fan volumes ≥ 5000 cfm capacity shall have a dispersion study.

Dispersion studies shall be *considered* for all other renovation projects. For example, a project installing a new outdoor air intake on a lab building likely would justify a study.

Since the results of dispersion studies often require the A/E’s initial design to be modified, they should be started as early as possible in the design process.

Design Fundamentals

General:

The specific standards that apply to a particular project should be determined during programming. The following are typical requirements:

Research labs: NFPA 45 Standard for Fire Protection for Laboratories Using Chemicals.

Hospital: All hospital projects governed by the Michigan Department of Health, Health Facilities Evaluation Section, shall comply with the Minimum Design Standards for Health Care Facilities in Michigan, and NFPA 99 Standard for Health Care Facilities.

The guidelines expressed herein are meant to supplement, not supersede, code requirements. Where conflicts exist, the AE shall review with the U-M Design Manager.

Designs may also need to comply with various U.S. Government standards or guidelines (e.g. National Institute of Health, Department of Agriculture, etc.); establish which apply during project programming phase.

Laboratory supply and exhaust air shall be dedicated to lab areas within the building and shall not be part of HVAC systems serving other building areas (offices, toilet rooms, vivariums, etc.).

Lab general and fume hood exhaust shall be manifolded whenever possible, as permitted by code, to reduce first cost and improve energy efficiency and maintainability.

Supply air shall be “once through” (100% outside air); it shall not be recirculated outside a laboratory room. Air may be recirculated within the laboratory room itself, e.g. local fan coils. Some very low hazard level labs may use recirculated air when approved by U-M OSEH.

The use of non-DX type fan coils or chilled beams for sensible loads is encouraged to reduce the amount of outside air required for lab cooling. For labs affecting patient care in hospital facilities, the Minimum Design Standards for Health Care Facilities in Michigan precludes the use of recirculating fan coil units in labs unless outfitted with a HEPA filter.

Rooms and LTAUs shall be scheduled. Provide all of the information contained on the U-M sample schedule Laboratory Terminal Air Flow Unit Sample Schedule.

HVAC systems used for laboratories, including those with chemical fume hoods, shall be designed for variable air volume (VAV) using tracking supply, general exhaust and fume hood LTAUs. While this means supply and general exhaust shall be variable flow, it does not necessarily mean fume hoods are to be variable flow:

For purposes of initial program budget, the use of VAV fume hoods/controls should be assumed. As the program is further developed, evaluate and justify VAV vs CV fume hoods. When analyzing the potential benefit of VAV type fume hoods, evaluate with and without automatic sash lowering devices.

- Evaluate if the LMVR (see LMVR discussion below) for the room precludes the use of VAV hoods because general exhaust would increase to maintain the LMVR as the hood sash was closed.
- Assume fume hood sashes with automatic devices will result in an average hood air flow reduction of 30%,
- Assume fume hood sashes without automatic devices will result in an average hood air flow reduction of 10%.
- Hood with combination sashes must be equipped with VAV LTAUs/controls.

Do not diversify fume hood loads relative to exhaust fan/system sizing; assume all hoods are at 14” sash position at all times .

Size supply and exhaust systems with additional capacity for future use. Determine the appropriate additional capacity in consultation with the U-M Design Manager. Minimum additional capacity: 10%.

Size fume hood LTAUs and the associated LTAU branch duct as follows:

- Full Bypass Constant Volume Type: For the air volume required to attain 100 FPM at full open sash position.
- Partial Bypass Constant Volume Type: For the air volume required to attain 100 FPM with sash at sash stop position.
- Restricted Bypass VAV Type: For the air volume required to attain 60 FPM at full open sash position, 100 FPM with sash at sash stop position.
 - Combination Sashes: 100 FPM must be achieved with the sashes in the position that creates the maximum free area opening. Example: If the sash has 4 horizontal sashes, the face velocity must be achieved with 2 sashes in the full open position (with the sash vertical position closed).
- Full Bypass Constant Volume **RFV** Type: For the air volume required to attain 70 FPM at full open sash position.
- Partial Bypass Constant Volume **RFV** Type: For the air volume required to attain 70 FPM with sash at sash stop position.
- Restricted Bypass VAV **RFV** Type: For the air volume required to attain 60 FPM at full open sash position, 70 FPM with sash at sash stop position.
 - Combination Sashes: 70 FPM must be achieved with the sashes in the position that creates the maximum free area opening. Example: If the sash has 4 horizontal sashes, the face velocity must be achieved with 2 sashes in the full open position (with the sash vertical position closed).
- Exhaust Valves for Floor Mounted Hoods: Must use VAV type LTAU/controls. The exhaust air valve shall be sized so that the required face velocity can be achieved with one sash fully open. Example: If sash is 28" high and can be opened to create a free area opening 28" high, the exhaust air valve must have enough capacity to achieve the required face velocity (e.g. 100 FPM) at 28".

LMVR: Lab Minimum Ventilation Rate

Each lab room shall be ventilated at a minimum Lab Minimum Ventilation Rate. The LMVR shall be established in consultation with U-M OSEH, and shall be in compliance with codes and the Minimum Design Standards for Health Care Facilities in Michigan (when applicable). Typical LMVRs, room pressurization, and air flow control requirements can be found in Appendix A of this Design Guideline.

Negative or Positive Pressure

Pressurization in and out of rooms shall be indicated on plans with directional arrows and airflow quantities (CFM).

Sealing of all room penetrations and joints shall be specified to maintain space pressurization.

If a local means of adjusting space pressurization is requested (typically accomplished with a potentiometer), specify that the adjustment device be clearly labeled to identify which direction produces positive or negative pressurization adjustment. Specify a locking enclosure for the adjustment device. Local means of adjusting pressure is discouraged.

Laboratory Pressurization Gauge

Local pressure indication is not typically required for general purpose labs.

Provide room pressure indication for rooms indicated in Appendix A. Consult Appendix A for indicator requirements.

Emergency Operation

Provide emergency power for laboratory systems where a power failure endangers life safety.

Exhaust fans and corresponding supply fans shall automatically restart when power is restored after a power failure.

Fire detection and alarm systems shall not be interlocked to automatically shut down chemical fume hood exhaust. Exhaust fans shall continue to operate in the event of a failure or alarm condition of the supply air system. For example, if the supply air handler trips on freeze stat or smoke detector, the associated lab exhaust fan(s) shall not shut down. Proper door operation for egress shall be maintained when the supply system shuts down and the lab exhaust system continues to operate, creating a pressure differential. Some large systems may require a design that automatically reduces exhaust fan volumes, to prevent excess negative pressure at egress doors.

Indicate in the Design Intent Document, exhaust system operation under all emergency conditions (loss of power, fire, supply air failure, etc.).

Vivariums:

Vivariums require dedicated, fully redundant air handlers. Vivarium air handlers, animal room exhaust systems, terminal units, and controls shall be fed from the emergency power system.

The air valves serving animal holding rooms shall be selected such that air flow to those rooms can be increased an additional 10% minimum, future. Size the vivarium air handler with sufficient capacity to accommodate this additional air flow capability.

Reheat coils shall utilize normally closed (N.C.) control valves to prevent over-heating animals upon a valve failure.

Each animal room exhaust shall be equipped with a duct mounted filter rack. Exhaust grille style filter frames are not preferred but may be used with the permission of the U-M Design Manager.

Laboratory Exhaust Duct

Materials

The below descriptions are considered normative for U-M lab projects; however the A/E shall give consideration to the nature of materials being exhausted and shall specify appropriate duct materials, construction methods (e.g. gasket and sealant types, etc.), and duct coatings.

Lab General Exhaust: G-90 galvanized where accessible. Specify plastic coated duct (PCD) in concealed spaces, including shafts.

Chemical Fume Hood Exhaust: PCD from hood to main lateral. If there is insignificant general exhaust flowing through the main lateral, specify PCD for the entire exhaust duct run.

Cage and rack washers, sterilizer and glass washer hoods, and any ductwork carrying moist air: “seal” welded (water leakage tight) 316 stainless steel, from hood to main lateral. Duct shall slope back toward the hood so that any condensate formed in the duct drains away from the main lateral duct. Hoods shall have drain lips, piped to a local floor drain.

Acid Exhaust: Teflon lined stainless steel duct shall be consider in lieu of FRP duct. Note: Obtain concurrence from U-M OSEH that exhaust acidity justifies these specialized materials.

Cage and rack washers shall be exhausted via a dedicated exhaust fan. Therefore the associated duct shall be stainless steel all the way to the exhaust fan, routed as directly as possible, avoiding horizontal runs. LTAUs shall not be used.

Construction

Prohibit tie-rod re-enforcement methods for PCD. Prohibit tie-rods in any duct carrying corrosive exhaust.

Exhaust ducts running on the building exterior will typically require insulation to prevent condensation formation inside the duct during cold outside air conditions. Evaluate the need for drains on exterior horizontal exhaust duct work; see “Fan Construction” for additional considerations regarding such drains.

For exhaust duct connected to animal rooms, specify riveted duct upstream of filters.

Fire and/or Smoke Dampers

Not allowed in laboratory exhaust ductwork per NFPA 45.

Exhaust Fans

Fan Capacity

Specify at least 10% additional design flow at the required system static pressure for all lab exhaust fans.

Fan Selection/Number of Fans

For lab exhaust systems over 10,000 CFM capacity, provide 100% redundant standby fans.

For systems 10,000 CFM or less, consider two fans at 50% capacity each.

For all critical exhaust systems, e.g. Biosafety Level 3 labs, provide 100% redundant standby fans.

Cage and rack washers shall be exhausted via a dedicated exhaust fan.

Fan Types

Centrifugal fan systems are preferred, provided it can be shown they safely disperse the effluent. Provide direct drive fans when available.

Direct-drive, high-plume exhaust fans shall be provided on systems above 5000 CFM when no fan redundancy is provided, or when found to be required by dispersion studies.

Location and Design

Exhaust fans shall be located on a roof so that all duct in the building is negatively pressurized. If a roof location is impossible and the fan(s) must be located in a mechanical penthouse or room, design an air tight enclosure around the fan(s) and specify that the discharge duct from the fan be seal welded. Contact the U-M HVAC/Controls Mech Tech team for additional info on air tight enclosures. Provide windows in enclosures to facilitate maintenance.

The fan stack velocity shall be maintained through the use of normally-closed bleed-in dampers or other means. VSDs shall not be used to maintain stack velocity.

Orient the fan discharge duct (stack) vertically from the fan outlet. Extend stacks a minimum of 10 feet above the highest local roof. Design the stack to provide a minimum stack discharge exit velocity of 3000 FPM unless a dispersion study demonstrates a lower tip velocity achieves the required dilution target.

Fan stacks shall be self-supporting. Guy wires shall not be used without the permission of the U-M Design Manager.

Fan Construction

Fan housings (centrifugal fans) shall be welded construction with a cleanout door.

Typically fans, fan blades, fan plenums, plenum access doors, and fan back-draft dampers should have a Heresite anti-corrosion coating. Specific applications may require different anti-corrosion coatings. It is the A/E/Lab Planners's responsibility to select appropriate coatings. Also specify a heavy-duty coating for the exterior surfaces that prevents corrosion.

Provide a scroll drain for centrifugal fans (drain valve with hose connection). Fans located in enclosures shall have scroll drains piped to the enclosure exterior, with the drain valve and hose bib on the outside, and the drain labeled as a hazard.

Similar to scroll drains, provide drains in exhaust plenums located outside (drain valve/hose connection/cap). Depending on the relative humidity of the space being exhausted, some exterior plenums will require drains that continuously remove routine condensation formation occurring in winter months. Such drains should be routed to termination points inside the building, and be properly trapped. Provide trap primers. Portions of such drains located outside must be heat traced. Similarly, evaluate the need for drains on exterior horizontal exhaust duct work.

Flexible Connectors

On positively pressurized duct work, flexible connectors are prohibited indoors, except for exhaust fans mounted inside enclosures. Fabric flexible connectors shall never be used. One piece flexible rubber/elastomeric connectors may be used in some low risk applications, with the approval of the U-M Design Manager

Dampers

Motorized control dampers shall be used to prevent back drafting of exhaust fans. Such dampers shall be designed to fail to the “open” position on loss of power. These same dampers shall close when the fan is turned off by normal means.

Motorized bleed-in dampers shall fail to “closed” position.

Damper actuators shall be located outside of the exhaust air stream.

A method of preventing excess negative duct/plenum pressure shall be provided.

Damper construction shall meet or exceed ductwork construction (i.e. protective coating, stainless steel, etc.)

Exhaust Filters

The installation and type of filter in the laboratory exhaust system (if any) shall be determined by The Department of Occupational Safety and Environmental Health (OSEH) or the Radiation Safety Control Department of the University of Michigan, and in compliance with requirements stated in Minimum Design Standards for Health Care Facilities in Michigan, when applicable.

Radioactive hoods typically do not require filters.

All exhaust filters shall be provided with a differential pressure gauge to indicate pressure drop across filter.

Exhaust systems with filters that require a specific stack velocity to achieve required dilution targets must include provisions to maintain stack velocities as filters load up.

Exhaust System Fan Control

Exhaust fans shall be controlled by the owners Building Automation/DDC System. See U-M Design Guideline 15975 Mechanical Systems Controls.

Laboratory Terminal Airflow Units (LTAU) and LTAU Control

Venturi valve type terminal units shall be specified. U-M Master Specification sections 230910 and 230920 specify lab terminal airflow units and associated controls and shall be used as the lab controls specification on projects.

- **230910** covers **digitally controlled** lab terminal air flow unit controls and is typically used for all new buildings and major renovations.
- **230920** covers **analog electronic** lab terminal air flow unit controls and is typically used for smaller renovations where analog electronic air flow controls already exist and it makes sense to reuse them.

Consult the U-M Design Manager to establish which type lab controls are to be used for a specific project, early in design.

Edit U-M Master Specification 230910/230920 to make it project specific.

Sizing fume hood LTAUs: See “HVAC and Exhaust Systems Design”, above.

Vivarium LTAU Sizing: The air valves serving animal holding rooms shall be selected such that air flow to those rooms can be increased an additional 10% minimum, future.

Hood Type: Designate hood type served by each LTAU on the architectural/lab plan as well as the mechanical design drawings.

Sash Type: For VAV LTAUs, designate if sash is vertical rising or combination type on the design drawings. Combination sashes shall not be used on constant volume hoods.

Sash Alarms: Are to be specified for all hoods. Specify that sash alarms meet the following requirements:

- Shall alarm when the sash is above the sash stop position. Provide audible and visual alarm and alarm silence (mute) button.
- A separate visual alarm indicator shall be provided to indicate the sash position alarm, labeled "Sash High" or similar language that makes it obvious that a high sash condition has created the alarm.
- If the mute button is pressed during a sash position alarm condition, the audible alarm will not silence, or will silence for a maximum of 1 minute. The visual indicator shall remain lit.

- Both the audible and visual alarms shall reset to a non-alarm state when the sash is returned to a position at or below the sash stop position
- The alarm point shall be adjustable to accommodate various sash stop positions.
- Manufacturer shall provide all necessary components to monitor sash position.

Air Balancing: Indicate on drawings that the LTAU air volume is to be balanced to achieve 100 FPM average face velocity with sash at sash stop position for standard hoods, 70 FPM average face velocity with sash at sash stop position for RFV hoods.

Fume Hood Exhaust Monitor Alarm Setting: Indicate settings on drawings as 80 FPM for standard hoods, 60 FPM for RFV hoods.

Fail Mode: Generally, supply LTAUs shall be indicated to fail closed and exhaust LTAUs shall be indicated to fail open.

Coatings: Specify Heresite coating (minimum) for LTAUs serving chemical fume hoods. Specify other protective coating types, as application dictates.

Balancing Damper: Provide a stainless steel balance damper downstream of all LTAUs serving chemical fume hoods, for testing purposes.

Clearances: Utilize U-M Standard Detail Laboratory Terminal Air Flow Unit Clearances to indicate required clearances. “Dash out” required clearances at each LTAU on the plan views. Require that LTAUs be mounted no higher than 2’ above the ceiling grid.

Power Requirements for LTAUs: Designate circuits in receptacle panels on each floor for LTAU power supplies. Work with LTAU suppliers to determine the number of 20 amp circuits required. Do not exceed 50 LTAUs per 20 amp circuit.

Power Requirements for Fume Hood Exhaust Monitors: Designate circuits in receptacle panels on each floor for Fume Hood Monitors. Work with LTAU suppliers to determine the number of 20 amp circuits required. Do not exceed 10 Fume Hood Exhaust Monitors per 20 amp circuit.

LTAUs are Prohibited: On exhaust connected to cage and rack washers, due to severe corrosion problems U-M has experienced even when coated LTAUs have been provided. A dedicated exhaust fan is required to serve cage and rack washers.

Laboratory Supply Air Diffusers and Registers

Terminal Velocity

Terminal velocity of supply air near fume hoods, bio-safety cabinets, etc., is as important as hood velocity and should preferably be no more than 1/2 the hood or cabinet face velocity (near the hood). Therefore terminal throw velocities in areas with hoods or cabinets should be far less than typical for general lab air supply locations.

Optimize design and layout of supply air devices in consideration of all lab requirements, including velocity, throw and low flow performance.

Perforated Diffusers

To avoid cross draft problems, when supply diffusers must be located near fume hoods or other sensitive cabinets, consider perforated diffuser technology (similar to Titus RadiaTec, VersaTec ,or TriTec) that diffuses supply air at high volumes and low velocity. When RFV hoods are used, Titus VersaTec diffusers shall be specified for the immediate ceiling vicinity near the RFV hood.

Wall Registers

If wall registers are used in labs with hoods or cabinets, they should have double deflection louvers and shall be set for maximum deflection position away from the hood.

First Cost Optimization/Energy Conservation

Comply with U-M Design Guideline SID-D.

Provide fan coils/chilled beams or other strategies to reduce the quantity of “once-through” outside air required for cooling. Chilled beams, if proposed, shall be reviewed and approved by the HVAC/Controls Mech Tech Team.

In spaces with high once through air requirements (> 6 ACH), evaluate strategies to reduce reheat coil pressure drops, such as larger face area reheat coils or radiant heating panels or floors in lieu of duct reheat coils.

At each phase, the A/E/Lab Planner shall calculate the following and indicate the result in the Design Intent Document:

- Fume hood density per 5000 gsf of building
- Fume hood density per 5000 nsf of lab

Densities above 3 hoods per 5000 gsf shall be justified. Consider alternatives such as snorkels and chemical storage cabinets.

Evaluate the following technologies (also see “HVAC and Exhaust Systems Design”, above, for required analysis parameters):

- Variable volume hoods
- Automatic sash closure systems
- Controls to reduce the minimum room air change rate when the lab is unoccupied.

Note: By ruling of U-M OSEH, devices to reduce hood face velocity when users are not standing in front of the hoods, e.g. “zone presence sensors” or other means, SHALL NOT be used.

Evaluate Reduced Face Velocity hoods.

Improve ventilation air flow efficiency by reducing the pressure drop of air system components. The following targets (maximums at full design flow) shall be met for all once through air handlers that will run continuously:

- Air Handler Component Face Velocity: 400 FPM
- Total supply and exhaust duct pressure drop: 2.25 in. w.g.
- Noise Control (silencers) 0.25 in. w.g.

For manifolded exhaust systems, evaluate the energy benefit gained from additional fan staging (i.e., from smaller staging increments), by increasing the number of fans drawing air from common exhaust plenums.

Exhaust Air Heat Recovery: Evaluate heat recovery (enthalpy) wheels, flat plate air-to-air heat exchangers, heat pipes (including pumped type), and run-around coils. Include impact of additional pressure drop through each device type.

Avoid tight temperature and humidity requirements. Normal lab setpoints are:

Summer: 74 dbt minimum, humidity floating but no greater than 60% RH

Winter: 70 dbt maximum, humidity floating but no less than 25% RH.

Setpoints outside these ranges shall be justified in the Owner's Project Requirement/Basis of Design (aka Design Intent) Document.

Measure comparable U-M laboratories to establish HVAC plug/equipment loads during early SD phase, and base the lab design on this measured data. For each comparable laboratory space, obtain 7 days of continuous power metering at the branch circuit panel level of all lab equipment, including plug loads and hard wired equipment, while the spaces are fully occupied. Continuous metering data shall include:

- Apparent instantaneous power
- Real instantaneous power
- Real power averaged over 15 minute intervals

The design heat load criteria shall be based on the 15 minute time averaged Real power draw of the comparable space, unless the lab user group can validate higher heat load requirements. U-M will provide the labor to take the measurements, however the A/E/Lab Planner in conjunction with the U-M Design Manager will identify comparable laboratories and analyze the collected data.

Laboratory luminance levels shall not exceed IESNA Handbook (most recent edition) foot candle levels.

Appendix A

Laboratory Minimum Ventilation Rates (LMVR)

Each lab **room** shall be assigned a Lab Minimum Ventilation Rate (LMVR). The LMVR assigns the minimum air change rates to each lab room based upon an assessment of the potential airborne hazards. This minimum air change rate is the amount of 100% outside air that must be delivered to the space, expressed in air changes per hour (ACH) ¹.

The LMVR shall be assigned by U-M OSEH Research, Health, and Safety. The assessment involves a review of potential airborne hazardous materials present, quantities, operations, engineering controls and facility history. Table 1 provides the typical LMVR and other requirements by lab room type, for use prior to U-M OSEH approval. The minimum amount of 100% outside air to be delivered to the lab room shall be the higher of the LMVR or any code (e.g. ASHRAE 62.1) or governing standard's requirement.

There are five LMVR classes ranging from the least hazardous (LMVR 0) to the most potentially hazardous (LMVR 4). Air change rates are provided for both occupied and unoccupied conditions. Where an unoccupied ACH is allowed and implemented, automated methods must be provided to notify lab occupants when the room is in unoccupied mode, and to return the room to the occupied mode air change rate. One method acceptable in many lower risk labs is to set back to unoccupied LMVR based upon occupancy sensors which simultaneously turn lab general lighting off. When the lab is re-occupied, the lights automatically switch back on and the occupied LMVR is reestablished. Local indication, such as by a blinking pilot light near the lab door(s), may be required for higher risk labs. The automatic set back method and occupied/unoccupied indication for each lab room shall be approved by U-M OSEH. Flow rates through fume hoods and similar hazardous exhaust capture devices shall remain the same in both the occupied and unoccupied lab modes.

LMVR 0: No Laboratory Hazards (4 ACH occupied, 1 ACH Unoccupied)

Laboratories in this category have no significant airborne hazards or materials. LMVR 0 typically includes dry research labs, laser labs without gases, electronics labs, machine shops, and fabrication labs, with appropriate engineering controls at low hazard emission sources.

LMVR 1: Low Hazard (6 ACH occupied, 4 ACH Unoccupied)

Laboratories typically in this category are open wet research labs, microbiology, genomics, or proteomics labs with minimal quantities of hazardous chemicals,. Hazardous air emissions may exist but are well controlled with standardized equipment and procedures. Includes standard biomedical research involving CDC Risk Group 1 or 2 agents. Only low hazard compressed gases in small quantities are allowed. A risk assessment of actual conditions of use may dictate a higher LMVR depending on bulk quantities and dispensing methods.

¹Air exhausted from the space to meet the LMVR must not be recirculated. Supplemental, recirculated, and cooling air does not apply toward ACH.

LMVR 2: Constant Hazard – Constant flow required (6 ACH occupied, 6 ACH Unoccupied)

LMVR 2 labs are relatively low hazard labs. Typical chemical work involves small volumes of solvents, acids and toxic chemicals. Hazardous materials are used with good engineering controls as necessary. Only low-hazard gases are used like CO₂ and N₂. Well managed clinical labs working with solvent, formaldehyde, and tissue preparation procedures with good engineering controls are included in LMVR 2. Flammable liquid storage rooms are LMVR 2.

LMVR 3: Moderate Hazard (8 ACH occupied, 4 ACH Unoccupied)

Labs working with non-production volumes of many toxic and flammable chemicals and volatile solvents. Use of carcinogens, pyrophorics, acutely toxic materials, sensitizers, and reproductive toxins is in small quantities. Chemistry or pharmacy teaching labs are in this group.

LMVR 4: High Hazard (10 ACH occupied, 6 ACH Unoccupied)

LMVR4 has the highest potential severity of hazards present. LMVR 4 labs typically work with large or production volumes of solvent or corrosives, and/or large quantities of particularly hazardous materials (nanomaterials, chemotherapy agents, highly toxic compounds). Labs working with gas cylinders of toxic, pyrophoric, or flammable gases are included in this rank. Synthetic chemistry and CDC Risk Group 3 biological agents or Select Agents are typically included in LMVR 4. Unique use of hazardous materials, lab equipment, or research fabricated equipment with the potential for air emissions may also be classified into LMVR4.

Table 1: Lab Minimum Ventilation Rate, Pressurization, and Air Flow Control

Room Type	LMVR	Air Flow Control	Pressurization	Comments
Dry Research Labs	0	V	N	
Laser Labs	0	V	N	Without gases
Open Wet Research	1	V	N	Includes both research and teaching type
Microbiology Labs	1	V	N	
Genomics Labs	1	V	N	Including DNA processing type
Proteomics Labs	1	V	N	
Analytical Labs	1	V	N	
Tissue Culture Rooms	1	V	N	Pressure relationship is dependent on project, typically negative. Provide visual pressurization indicators.
Linear Equipment Corridors s	1	V	N	And similar equipment rooms
Equipment Rooms with Freezers	1	V	N	

Lab Storage Rooms	1	V	N	Including similar lab support spaces
Autoclave and Dishwashing Rooms	1	V	N	
Flammable Liquid Storage Rooms	2	C	N	
MRI and NMR Rooms	2	V		
Cryogenic Liquid Storage or Dispensing Rooms	2	V		
Animal Holding Rooms: Ventilated Racks	2	C		Pressure relationship is dependent on project. If ventilated racks with rack mounted fan packs are utilized, room air change rates must be as listed for static rack rooms. Provide visual pressurization indicators.
Animal Procedure Rooms	2	C		Pressure relationship is dependent on project. Provide visual pressurization indicators.
Animal Holding Rooms: Static Racks		C		ACH typically 10 occupied, 10 unoccupied. Pressure relationship is dependent on project. Provide visual pressurization indicators.
Chemistry Teaching Labs	3	V	N	
Pharmacy Teaching Labs	3	V	N	
Synthetic Chemistry Labs	4	V	N	
Nano-Labs	4	V	N	
Chemotherapy Labs	4	V	N	
CDC Risk Group 3 Biological Agents or Select Agents	4	V	N	
Laboratories affecting Patient Care in U-M Hospital & Health Center Facilities				See "Minimum Design Standards for Health Care Facilities in Michigan."

Table Key: LMVR: Lab minimum ventilation rate **C:** Constant Volume **V:** Variable Volume
N: Negative **A:** Adjustable **P:** Positive

Table Notes:

Table 1 indicates the LMVR, method of air flow control, and room pressurization relative to adjacent spaces, for typical laboratory and vivarium spaces at U-M. The above table is a guide only; requirements must always be validated for the specific project. Air flow control refers to typical control of supply air to the space and is a generalization; the project must determine the appropriate air flow control for the space.

For variable volume systems, the minimum setting of terminal units (LTAUs) shall provide the room air changes per hour (ACH) value indicated by the LMVR designator, or as required by code (ASHRAE 62.1) or governing standard, whichever is higher. Indicate this minimum (CFM) setting on the drawings. The maximum settings, which shall also be indicated on the

drawings, shall be as required to account for sensible and latent loads, and for exhaust make-up. Where a unoccupied ACH is permitted by the LMVR designation, , such spaces shall, if meeting a 8 year simple payback criteria (SID-D), be provided with methods (e.g. occupancy sensors, etc.) to allow un-occupied setback to the minimum ACH. See the LMVR narrative, above, for additional requirements.

All rooms where bio-hazardous research is conducted shall be designed to provide negative pressure relative to adjacent spaces, and shall include visual pressure indication. Bio-hazardous research is defined as:

- A. Recombinant research at BSL 2, 2+, or 3, as classified by the NIH office of Recombinant DNA Activities.
- B. Infectious disease research at BSL 2 or 3, as classified by CDC/NIH Biosafety Guideline.

Offices contained within lab areas shall operate as positive with respect to the lab.

Where indicated, visual pressurization indicators shall be provided so that room occupants can locally verify the direction of room pressurization. Provide analog room pressurization gauges outside and above laboratory door(s) (*inside*, outside, and above the door of BSL-3 labs) to indicate pressurization. Analog gauges are preferred over the installation of “ping pong ball” style indicators. Specify a gauge range that will indicate both positive and negative pressure. Typical range: negative 0.25 to positive 0.25 inches w.c.

Appendix B

Perchloric Acid Fume Hood Systems

Perchloric acid fume hood designs shall be reviewed and approved by U-M Occupational Safety and Environmental Health Department (OSEH). The following are general guidelines. The designer should also adhere to the perchloric hood requirements found in NFPA 45.

Exhaust System:

Provide a dedicated exhaust system for perchloric exhaust. Do not manifold with other exhaust systems (e.g. toilet exhaust, particulate exhaust, etc.).

Terminate vertical stacks no less than 100 feet from an air intake.

Equip the ventilation system with a built-in water wash-down system. Automatic wash-down systems are normally recommended and should be reviewed with the U-M Design Manager and U-M OSEH. Ensure that the system will adequately spray all interior surfaces of the duct, plenum, fan, fan stack, and hood. Additionally, perchloric acid fume hoods shall be provided with wash down nozzles for rinsing the area behind the baffle. Service fitting controls for internal outlets and for the wash-down system shall be external to the hood. Drain(s) shall be provided to catch the wash-down water. The point of drain discharge shall be approved by U-M OSEH. Drain material shall be polypropylene. A backflow preventer shall be provided on the cold water supply to the wash-down system. Provide a frost proof hydrant near the fan/fan stack to allow manual wash-down.

Duct:

Route via the shortest and straightest route possible to the outside, with no offsets or horizontal runs. Provide positive drain back to the hood. Indicate clearly on the design drawings that the contractor may not modify the duct design without written approval from the engineer.

Duct material: acid resistant, non-reactive materials selected for the specific chemical use in the hood; typically shall be all welded 316 stainless steel. For final connections where welded joints are not possible, specify gaskets and sealants that are non-reactive and resistant to perchloric acid. Require 316 stainless steel fasteners or fasteners with corrosion resistance equivalent to the selected duct material. Specify that all duct shall be watertight.

Flexible connections shall not be used.

Provide access to permit visual inspection of duct internals.

Labeling:

Require duct, fans and stacks to be marked as follows:

EXPLOSION HAZARD

Do no service work or inspection on this duct without prior approval from U-M
Occupational Safety and Environmental Health Department.

Locate markers near points where ductwork originates or continues into shafts, floors or walls, and at maximum 5' intervals along duct runs.

Fans:

Eductor type fans systems shall normally be used in lieu of conventional fan arrangements.

Specify acid resistant, non-reactive fan materials selected for the specific chemical use in the hood. Teflon or PVC coated blades can typically be used.

Specify Type A spark proof fans.

Specify fan types with fan motors located outside the duct work. Drive belts shall be non-spark conductive type and shall not be located within the ductwork.

Appendix C

Definitions

For definitions of various laboratory chemical fume hood types, refer to U-M Master Specification 115313 Laboratory Chemical Fume Hoods.

Capture Velocity

The air velocity at the hood face or capture device necessary to overcome opposing air currents, and to contain contaminated air within that device.

Face Velocity

Speed of air moving into fume hood entrance or working access opening, usually expressed in feet per minute (FPM).

Hood - Laboratory Chemical Fume

A ventilated, enclosed work space intended to capture, contain and exhaust fumes, vapors and particulate matter generated inside the enclosure. Biological Safety Cabinets are not fume hoods and the two are not interchangeable.

Hood - Auxiliary Air Chemical Fume

A fume hood typically using “raw” outside air for make-up air; should not be used at U-M except by special permission from the U-M Design Manager.

Laboratory Terminal Airflow Unit (LTAU)

Venturi-type terminal control valve.

Main (duct) Lateral

Large duct main running on a lab floor with multiple fume hood and general exhaust duct connections such that the large proportion of general exhaust connections is expected to result in a very dilute exhaust air stream.

Make-Up Air (Once-Through Air)

The supply of outdoor air to a building replacing air removed by exhaust ventilation systems.

Seal Welded Duct Joints

Both the longitudinal and transverse duct joints are continuously welded to form a 100% air and water tight seal.

Vivarium

A cluster of animal housing areas and support facilities. Fume hood and other exhaust accessories are often included as part of the design for these facilities, and therefore require special system design considerations.



HYDRONIC SYSTEMS AND SPECIALTIES

General

This section covers requirements for hydronics systems, including chilled water, hot water heating, and condenser water systems.

Related Sections

U-M Design Guideline Sections:

[221113 – Basic Piping Materials and Methods](#)

U-M Master Specification Sections:

[221113 – Basic Piping Materials and Methods](#)

[232116 – Hydronic Piping Specialties](#)

Design Requirements

Compression/Expansion Tanks

Provide compression tanks on all closed loop hydronics systems. Tanks shall be diaphragm/bladder type, constructed for appropriate design pressure. The tanks should be welded steel, stamped with ASME code Section VIII for appropriate psi design. Indicate system volume, and expansion tank fill and operating pressures on design drawings.

Air Separators

Install air separators to aid removal of air from hot water heating systems and as required for chilled water systems. Separators shall be a tangential type, designed and installed per manufacturers instructions

System Fill and Pressure Relief Valves

The design shall include system fill valve and pressure relief valve with a field adjustable pressure setting.

Balancing and Measuring Devices

All hydronic systems shall have a means of measuring and balancing flow at each piece of equipment and terminal device. Balancing valves shall be sized so they are not closed more than 60% for the flow and pressure expected. Do not base sizing on pipe size alone. If numerous devices are in the project, include a schedule on the drawings.

Automatic Flow Balancing Valves

Installation of automatic flow balancing valves is permitted for terminal devices (coils, finned tube radiation etc.), in lieu of installing manual balancing valves at these locations. Suitability of each application should be carefully considered by the A/E, especially in variable volume systems, and systems where design flow is likely to change and in existing systems.

Strainers and Dielectric Separation

Refer to U-M Master Specification 221113

Glycol Systems

Use of glycol in hydronic systems is generally discouraged due to environmental concerns. Glycol should only be used where other means of freeze protection are impractical. Use only concentrations required to meet design requirements. 30% ethylene glycol is typically acceptable for freeze protection on pumped hydronics systems subject to full winter conditions. Lower concentrations may be acceptable for burst protection or higher design temperature.

Do not provide an automatic cold-water makeup for glycol filled systems. Provide packaged, glycol fill system consisting of polyethylene fill tank (to hold approximately 30 gallons of pre-mixed solution) with hinged cover, fill pump and electric controls. Fill pump is to be energized to maintain system pressure as sensed by pressure switch mounted near compression tank. Provide a two stage low water alarm in the fill tank. The first stage alarms the campus BAS system (or, if BAS is not available, energizes an audible device). The second stage shuts off the pumps and requires a manual reset. Pipe relief valve back to the glycol fill tank.

Make provisions for filling glycol filled systems that ensure reasonable convenience, such that large drums will not need to be lifted up stairs.

Pre-mixed glycol is generally preferred.

Review need for containment with U-M Project Coordinator and U-M OSEH department. At minimum, include a spill pallet below the glycol fill station.

Cooling Tower Water (Condenser Water) Systems:

Tower Water systems generally require installation of side-stream aggregate filters, or possibly centrifugal separators. Consult U-M Project Coordinator. Refer to U-M details for chemical treatment and filters.

Installation Requirements

Expansion tanks and air separators shall be supported independently from piping.

Install air vents at all high points in all hydronic systems. Generally, automatic vents should be installed only in mechanical equipment rooms. All other locations will contain manual vents. Where practical, pipe outlet from automatic air vents to floor drains. Refer to Master specification and standard details.

Flow meters shall be installed with unrestricted lengths of straight pipes as required by the manufacturer.

Install unions, isolation valves and bypass lines on devices requiring removal for maintenance.

Generally, install strainers ahead of all hydronic system control valves, flow measuring devices and pumps.



PUMPS

Scope

Pump selection. Requirements for the following pump types:

- Domestic boosters
- Storm and sanitary sump pumps
- In-line circulators
- Base mounted end and double suction pumps
- Vacuum pumps
- Steam condensate pumps

Related Sections

Design Guideline Sections:

[220000 – Plumbing Design](#)

[230040 – Hydronic Systems and Specialties](#)

[230050 – Chilled Water Systems](#)

U-M Master Specification Sections:

[220523 – Valves](#)

[221113 – Piping Materials and Methods](#)

[221123 – Domestic Water Booster Pumps](#)

[221333 – Packaged Submersible Storm And Sanitary Pumps](#)

[230593 – Testing, Adjusting, and Balancing](#)

[232123 – Plumbing and Hydronic Pumps](#)

General:

U-M Master Specification Section 22 1123 shall be used as the basis for domestic water booster pump specifications on projects.

U-M Master Specification 22 1333 shall be used as the basis for packaged submersible storm and sanitary pump specifications on projects.

U-M Master Specification 23 2123 shall be used as the basis for plumbing recirculating pumps and hydronic pump specifications on projects.

The A/E shall edit the U-M specification to make it project specific. Turn on hidden text and read all spec. editor's notes when editing the specification.

A/E shall schedule all pump data on the drawings (not within project specifications).

Select pumps and motors to be non-overloading (not into the service factor), at pump run-out (right end of published curve).

Pump efficiency at design conditions should be close to, or left of, peak pump efficiency.

Mechanical seals shall be used on all pumps except fire pumps, where stuffing boxes shall be used.

In general, specify pumps with 1800 rpm motors, unless design condition necessitates alternate motor speed.

Where remote start-stop, or status monitoring is required, use combination magnetic starter or variable speed drive (not manual starter).

Sump Pumps

In general, design sump pumps based on a submersible, duplex pumping system. Include slide rail on all sanitary pumps and on storm water pumps with motors larger than 5 HP, or sumps deeper than 4 feet. Include lifting lugs on pumps, automatic pump alternator and non-mercury float switches. Specify one-point common alarm (indicating high level, pump failure, or seal failure), and connect to Building Automation System.

Base Mounted End Suction Circulating Pumps

Base mounted end suction circulating pumps shall be of the centrifugal single stage type, with back pull-out design. Pump and motor shall be connected through a flexible drive coupling, with safety guard.

Pump and motor shall be properly mounted and aligned on a common, welded, rigid structural steel or cast iron base, with an enclosed perimeter with opening for grouting in place. Base shall be grouted in place.

Base Mounted Double Suction Circulating Pumps

Base mounted double suction circulating pumps, shall be centrifugal, single-stage type with horizontal split case design for servicing the impeller without disruption of the piping. Vertical split case design is also acceptable, where floor space is at a premium.

Provide rigid steel grout base and grout as described for End Suction Pumps section above.

For pumps larger than 30HP, consider need for trimming impeller for improved energy efficiency, following initial testing and balancing. Consult U-M Design Manager.

In-Line Circulating Pumps

In-line circulating pumps shall be single stage; with cast iron body and bronze trim construction, unless special fluid handling dictates otherwise.

Vacuum Pump (Lab and Medical)

Vacuum pumps shall be bronze fitted, or all stainless steel, 1750 RPM and have mechanical seals. Vacuum pump package shall include tank with access hatch and all related controls and piping.

Coordinate equipment selection (rotary vane versus liquid ring) with U-M Design Manager.

System Application Requirements

Consider potential future expansion of pumped systems. Extent of expansion will be determined on a case-by-case basis. Consult with the U-M Design Manager for specific direction.

Domestic Water

Provide all bronze lead free construction or stainless steel construction for all domestic water pump applications.

Storm and Sanitary

Use submersible sump pumps as described in Sump Pumps, above.

Hydronic Systems (Chilled Water, Condenser Water, Hot Water Heating)

Use end suction, double suction or in-line pumps as described in Equipment Requirements above. Typically, use base mounted pumps for all applications over 10HP.

Install fully redundant (N-1) stand-by pumps for heating systems.

For chiller and cooling tower installations, refer to Design Guideline Section 230050.

Steam Condensate Pumps

Typically, use electric condensate pumps for steam condensate. Consider use of air operated condensate pumps (only with U-M Design Manager approval) in steam tunnels, or other spaces with high condensate temperatures.

Design of condensate pumping system must consider receiver size, location, NPSH, flash area, and receiver and flash tank venting (properly sized, routed to outside).

Installation Requirements

Install pumps and accessories in strict accordance with the manufacturer's requirements for maintaining satisfactory hydraulic performance.

Provide the following accessories for each pump (except sump pumps):

- Flexible connector, rated 2 times normal operating pressure, in suction and discharge lines. Refer to U-M Master Specification Section 221113. Flexible connectors are not

typically required on in-line pumps (allowing pumps to be supported from adjacent piping).

- Isolation valving on both sides of the pumps. Not applicable for sump pumps. For condensate pumps, suction valve must comply with U-M Master Specification Section 220523.
- On pump discharge:
 - Triple duty valve and an isolation valve, or
 - Non-slam check valve, throttling valve, means of measuring flow, and isolation valve. Install flow measuring devices in strict accordance with manufacturer requirements to ensure proper performance. Throttling valve shall be eliminated on variable flow (VSD) pumping applications.
- Pressure gauges on suction (prior to and after strainer) and discharge. For small, in-line pumps, pressure-temperature plugs may be used in lieu of gauges. Typically, these three points should use manifolded ½" piping, with isolation ball valves and a single, common gauge.

Provide the following accessories for each sump pump:

- Flexible connectors are not typically required on sump pumps, except where vibration necessitates.
- Pressure gauge, check valve and isolation valve on pump discharge. Separate throttling valve is not typically required.

Provide vibration isolation as necessary to prevent excessive noise and vibration. In general, install large pumps located above grade on concrete inertia base with spring vibration isolators. Where an inertia base is used, support piping near pumps with spring hangers. Support suction diffusers and piping directly in contact with pump from inertia base.

Suction inlet pipe for all pumps should be a straight section of pipe of not less than 10 pipe diameters in direction of flow. Where space conditions will not permit suction inlet pipe of required length, provide a suction diffuser.

Base mounted pumps shall be laser aligned. Typically, this should be specified as part of factory service technician start-up services.

For vibration testing requirements, refer to U-M Master Specification Section 230593.



CHILLED WATER SYSTEMS

General

The designer shall consult with the U-M Design Manager and Plant Operations before making decisions on chilled water system type and configuration.

Related Sections

Special Instructions to Designers:

[SID-J University Provided Utilities](#)

[SID-D Energy Conservation](#)

U-M Design Guideline Sections:

[230051 – Water Chillers](#)

[230052 – Cooling Towers](#)

U-M Master Specification Sections:

[232116 – Hydronic Piping Specialties](#)

[236416 – Centrifugal Water Chillers](#)

[236500 – Cooling Towers](#)

[230900 – Mechanical Systems Controls](#)

[232513 – Chemical Water Treatment – Closed Loop](#)

[232516 – Chemical Water Treatment – Open Loop Systems](#)

Chiller Plant Sizing, Redundancy, Diversity, Future Growth, Emergency Power

Calculate systems loads based on connected load (total of scheduled load at design condition) and peak diversified load (anticipated or measured actual peak load within a building or system that reflects diversity between loads). Base system sizing on peak diversified load (PDL). Consider potential need for future growth when calculating PDL.

Consider need for system and equipment redundancy. For critical laboratory and animal facilities and for multiple building chiller plants provide plant with multiple chillers to provide “N-1 redundancy” (capacity that can meet PDL with largest chiller, pump or cooling tower out of service). For single building chiller plants, the design shall provide at least, sufficient redundancy for the critical portion of the facility.

For building areas such as vivaria or certain hospital areas, requiring cooling operation during power outage, consider providing a smaller chiller connected to emergency power.

Redundant pumping shall be considered normal for all installations. For multiple chillers, design systems to provide a single redundant condenser water pump and a single redundant

chilled water pump that can be manually valved into service for the other pumps of the same service.

Chilled Water Configuration

In general, design systems with constant volume primary chilled water (through evaporator), with a decoupled variable flow secondary, with distribution based on two-way valve control of cooling coils. The decoupler pipe shall be sized to handle the full flow of the largest chiller. Chiller staging shall be via decoupler flow volume. For chiller plants of less than 1000 tons aggregate, serving a single building, variable volume primary systems may be considered with the approval of the U-M Project Coordinator, given a proper volume-controlled bypass arrangement is provided to maintain minimum chilled water flow at the evaporator.

For multiple building chilled water plants, design should normally indicate primary pumping, secondary distribution variable pumping and tertiary building pumping. The tertiary design should indicate a decoupled pumping arrangement with a modulating valve in the secondary return leg, which will maintain the tertiary at +1°F above the distribution temperature. For plants that serve newer buildings, design for a minimum distribution temperature differential (“delta T”) of 15° F (eg. 44F CHWS/ 59F CHWR). For plants serving existing buildings, the existing coil performance must be considered when defining system temperatures.

Design for Maintenance

Design piping and machine placement so that complete machine overhaul, including motor replacement, may be performed without the removal of permanent piping. Provide permanent steel rail hoistways or other approved measures for this purpose.

Where possible, locate chiller plant to minimize future work that will be required to replace the chiller.

Design for Cleaning/Flushing

Design system (include appropriate connections, etc.) such that, during construction, pipe cleaning and flushing can be conducted without contamination of the chiller. Design shall require provision of conical startup strainers at the chiller inlets and fine mesh pump startup strainers. Design shall incorporate temporary bypasses of cooling coils to avoid fouling coils during flushing and cleaning.

Water Treatment

Refer to U-M master specifications and guidelines. For systems over 400 tons, the design shall include chemical bulk storage adequate for a two month supply of chemical treatment and shall indicate a piping system for filling from a convenient grade-level loading area. Bulk systems shall be provided with double- wall storage vessels or other approved packaged base containment method. For smaller systems using 55 gallon chemical barrels, design shall include containment via a low, beveled curb that will allow wheeled hand truck passage along its length for barrel movement.

Strainers and Filtration

Basket strainers shall be provided for all cooling tower systems. In addition, provide coalescing type solids separators. Provide combination coalescing solids separator/air separators on the chilled water system. Sidestream separators shall be sized for at least one third of the full system flow.

Free Cooling and Winter Cooling

Where there is a significant winter chilled water load, consider “free cooling” (making winter chilled water utilizing a cooling tower and a plate-frame heat exchanger). Provide life cycle calculations in accordance with the Special Instructions to Designers (SID-J) Energy Conservation section. In addition to energy savings, free cooling can minimize low load short cycling. Filtration and wet-bulb approach controls shall be part of such a system.

Winter-operated cooling towers and outdoor piping shall be winterized in accordance with the Design Guideline section 230052 - Cooling Towers. Heat-trace systems shall be DDC controlled and monitored; separate programmable controllers are not permitted. Where winter chilled water demand is less than that practical for free cooling, provide a smaller indoor air cooled chiller with remote condenser connected in parallel with the larger chillers.

Drained Condenser Water Piping

If condenser water piping is intended to be drained down during off-season, consider the use of non-ferrous piping (stainless steel schedule 10 or other) for that section of piping to be drained to eliminate off-season corrosion of empty piping. Make provisions in the design (sight glasses and testing ports) so that risers within the building may be tested to insure treated water is present year-around.

Chiller Room Noise and Vibration

Consider noise and vibration criteria in mechanical room and adjacent area. Specify machine noise and vibration limits, and specify testing procedures. Evaluate the need for noise and vibration abatement to achieve acceptable noise levels.

Controls

Use of U-M standard control diagrams and sequences is preferred.

Chillers enable, start/stop functions, sequencing, cooling tower operation and secondary pumps shall be controlled by the Building Automation System (BAS). Use of proprietary chiller or pump control packages is not permitted. Generally, primary chilled water pumps and condenser water pumps are started and stopped by the associated chiller, but where redundant pumps are provided, using BAS to start pumps can be considered.

The design shall indicate manual selector switches, providing digital inputs to BAS, located at an auxiliary panel near the chillers for the following functions:

- Select lead/lag chillers sequence.

- Where BAS starts the pumps, to functionally connect the backup pump with the applicable chiller.

Cooling tower filter or separator blow down valves shall be controlled as the first stage of tower blowdown via the water treatment panel.

Generally, absorption chillers system design shall provide fixed constant condenser water temperature per design setpoint. Centrifugal systems design shall provide condenser water temperature reset; the chiller control panel shall generate a standard 4-20ma linear reset signal output to the BAS. BAS will reset condenser water setpoint, indexed against outside air wet bulb temperature.

Water cooled chillers or chiller groups shall have full-sized condenser water three-way valve bypasses of the cooling tower. Two way valves may only be utilized where specifically approved. The valve shall be controlled by the BAS with pneumatic controlled back up. For combination absorption and centrifugal chiller plants, separate three way bypasses shall be designed to provide higher fixed temperature to absorption and resetable lower temperature to centrifugals.

Control of water treatment shall be by the specified water treatment controller, which will report conductivity to the BAS.

Metering

Metering required:

- Cooling tower make-up water metering and cooling tower blow-down metering shall be in accordance with the City of Ann Arbor requirements and these standards. Meter cooling tower makeup water separately from the building service.
- For a chilled water plant serving multiple buildings, all utilities and services serving the generation of chilled water shall be metered separately from the building in which it resides.
- Each separate building using central plant chilled water shall have chilled water BTU load metering via a magnetic flow meter in conjunction with a BTU meter and sensors with matched calibration in accordance with the U-M Master Specification section 230900 - Mechanical Systems Controls.



WATER CHILLERS

General

Refer to SID-J, University Provided Utilities, for application of steam absorption chillers on Central Campus. Centrifugal chillers are the standard application for other campus areas. On Central Campus, generally capital replacement of absorption chillers shall be with like absorption chillers. Electric water chilling may be used for new loads.

Consult with the U-M Project Coordinator and Utilities and Plant Engineering before making decisions on chiller type. The following are general criteria:

- Air cooled packaged chillers: 100 tons and smaller.
- Water cooled screw chillers: 100 to 200 tons.
- Centrifugal and steam absorption chillers: 200 tons and larger.

Related Sections

Special Instructions to Designers:

[SID-J University Provided Utilities](#)

[SID-D Energy Conservation](#)

U-M Design Guideline Sections:

[230050 – Chilled Water Systems](#)

U-M Master Specification Sections:

[230930 – Refrigerant Detection and Alarm](#)

[232513 – Chemical Water Treatment-Closed Loop](#)

[232516 – Chemical Water Treatment-Open Loop](#)

[236416 – Centrifugal Water Chillers](#)

[236500 – Cooling Towers](#)

General Requirements

Unless directed otherwise, utilize the following U-M specifications as the basis for chiller specifications on projects. The A/E shall edit the specifications to make them project specific. Turn on hidden text and read all spec. editor's notes when editing specifications.

230930 – Refrigerant Monitoring System

232513 – Chemical Water Treatment-Closed Loop

236416 – Centrifugal Water Chillers

The capacity of the machine shall be based on Standard ARI-550-98 fouling factors for the evaporator, absorber and condenser sections, as stated in the U-M Master Specification.

Normally, for centrifugal and absorption machines, marine water boxes shall be specified for condenser and evaporator. Provide accessory davit arms or hinged covers for both evaporator and condenser boxes. Where marine boxes are not feasible, design shall indicate removable spool pieces between isolation valves and chiller heads, which when removed allow tubes to be pulled or cleaned. Design shall include permanent means to hoist and remove heads and spool pieces.

Chiller or chillers shall be sized to operate efficiently over the full range of the system load profile. Special caution shall be exercised to avoid sizing that results in short cycling in low load ranges. Multiple chillers shall be used if the load profile indicates that short cycling (cycling greater than 30 occurrences during a low load day) will occur. Multiple chillers shall be used in any installation of greater than 600 tons.

For small air-cooled chillers, consider providing an indoor chiller with remote condenser or dry-cooler in lieu of roof top chillers. Air cooled chillers operating year-around shall be rated for partial load performance at -10 F°. Chillers exposed to the outside air shall be designed with antifreeze water treatment for operation down to -10°F.

Chillers shall include manufacturer's standard digital control panel. BACnet panels and interfaces shall be provided only when specifically requested by Plant Operations.

Differential pressure switches for chiller proof of water flow shall be specified, not flow switches.

Provide life cycle cost analysis to evaluate chiller options. Contact Utilities and Plant Engineering for maintenance and utilities costs. Determine the system load profile. Evaluate alternative chiller assemblies. Investigate energy-saving opportunities where additional initial investment produces an acceptable payback in accordance with SID-D Energy Conservation. Consider providing variable speed drives (VSDs) for centrifugal chillers where the load profile exhibits an opportunity for acceptable payback. Use of VSDs on chillers must be approved by U-M Design Coordinator. For chillers larger than 200 tons, the specification shall require the manufacturer to provide, as part of their bid, annual energy usage based on a defined load model or ARI standard conditions, as applicable.

Normally chillers above 200 tons should be separately purchased and assigned to the mechanical contractor for installation. This allows the AE and the University to evaluate the chillers bids from a total (life cycle) cost perspective. U-M shall participate with the AE in chiller post bid evaluations, including attendance at post bid meetings.

Consider noise and vibration criteria in mechanical room and adjacent area. Specify machine noise and vibration limits, and specify testing procedures. Evaluate the need for noise and vibration abatement to achieve acceptable noise levels. See UM Master Specification for performance testing required after installation.

Mechanical Refrigeration Chillers

Centrifugal chillers should be specified to use HCFC-123 or HFC-134A (bidder's option). Screw chillers shall use HCFC-22.

Design and specification shall indicate each chiller to be provided with reseating relief valves and rupture discs. Vent the relief to the outside. Each resetting relief valve shall be designed to provide a digital input (contact closure) to the Building Automation System (BAS) on rupture.

For chillers over 300 tons, unless the chillers are installed near a convenient on-grade entrance, provide pump – down refrigerant reclaim tank and piping with capacity equal to 110% of the largest chiller in the installation.

For low pressure chillers, provide hose connections and power outlet for portable “hot pack” unit (to allow chiller to be heated to positively pressurize for service). Coordinate with U-M Project Coordinator as to whether a portable hot pack unit should be furnished with a new chiller installation.

When removing a chiller, specify and coordinate the removal of refrigerants by Plant Operations - Air Conditioning Shop, per EPA standards.

Specify that the chiller manufacturer conduct a full load factory performance acceptance test for each chiller and provide a certified test report for approval. Indicate that the capacity tolerance shall be zero and the allowable tolerance for other performance measurements shall be per ARI 550. Specify that the chiller not be shipped until the report is approved by the owner. Witness of testing by the owner shall be at the discretion of the owner with all travel expenses paid by the owner.

Specify that the chiller be provided with, on the control panel, a separate Hand-Off-Auto (HOA) switch which will allow selection of remote chiller start/stop or local start/stop. Specify that when the HOA is placed in off or hand, remote signaling shall not be able to control the chiller. Keypad activation is not permitted as a substitute for this function.

Provide refrigerant leak detection and ventilation in accordance with current standards and codes, including ASHRAE 15, Safety Code for Mechanical Refrigeration.

Steam Absorption Chillers

Absorption chillers shall be of hermetic design, factory assembled and leak tested, and selected for 5 psi steam at the inlet to the steam control valve. Unit shall be trimmed to 5 psi. Steam shall be controlled by low pressure drop control valve, limited to maximum 1 psig. The control will be a pressure independent control valves system, controlled by the unit control panel, which will permit operation of the unit at varying pressures (5-15 psig) without going into anti-crystallization mode at higher pressures.

If the unit is supplied with an anti-crystallization device such as a positive concentration limiter (PCL) valve, it must be provided with a factory installed manual bypass switch.

The unit shall be charged at the site with lithium bromide solution with chromate inhibitor or York's Advaguard 750. The lithium bromide solution shall be delivered to the site in approved containers and installed by the manufacturer at the site. The inhibitor shall be premixed into the solution before it is charged into the machine.

Tube wall shall be 0.028" for absorber, evaporator and condenser, and 0.035" for generator. The machine shall be supplied with 95/5 cupro-nickel tubes in the absorber, 90/10 cupro-nickel tubes in evaporator and generator, and 100% copper in the condenser section.

Pay particular attention to the manufacturer's requirement for minimum required vertical drop in the condensate piping between the concentrator outlet and steam trap inlet and proper pitch of the entire machine. Condensate lifting at the outlet of the machine is not permitted.

Instruct Contractor to arrange for a representative from the Plant Department through the University Project Coordinator to be present when the machine is initially charged with lithium bromide and water.

When an existing absorption chiller is to be removed, the lithium bromide is to be removed and legally disposed of by the contractor, with associated hazardous waste manifests filed with the U-M Project Coordinator and OSEH.

Specify that the chiller be provided with, on the control panel, a separate Hand-Off-Auto (HOA) switch which will allow selection of remote chiller start/stop or local start/stop. Specify that when the HOA is placed in off or hand, remote signaling shall not be able to control the chiller. Keypad activation is not permitted as a substitute for this function. Final trimming of absorption chillers by chiller manufacturer shall be done in conjunction with U-M Plant Operations and the Test and Balance contractor under full load conditions at the chiller. Since chiller start-up does not typically take place during peak cooling season, contractor must develop, assisted by the commissioner, a plan to fully load the chiller, either by imposing a false load or waiting to complete the contractually required trimming until a natural load can be developed. After the manufacturer trimming has been completed, manufacturer's representative shall perform final performance verification, measuring and document chiller performance under full load, witnessed by the commissioner.



COOLING TOWERS

General

This section covers requirements for forced draft and induced draft cooling towers, and related system and component requirements.

Related Sections

U-M Design Guideline Sections:

[230050 – Chilled Water Systems](#)

U-M Master Specification Sections:

[232513 – Chemical Water Treatment-Closed Loop](#)

[232516 – Chemical Water Treatment-Open Loop](#)

[236416 – Centrifugal Water Chillers](#)

[236500 – Cooling Towers](#)

Design Requirements

Unless directed otherwise, utilize the following U-M specifications as the basis for cooling tower specifications on projects. The A/E shall edit the specifications to make them project specific. Turn on hidden text and read all spec. editor's notes when editing specifications.

232513 – Chemical Water Treatment-Closed Loop

232516 – Chemical Water Treatment-Open Loop

236500 – Cooling Towers

Use 78°F for design entering wet bulb conditions.

Cross-flow induced draft towers are preferred over forced-draft type towers due to energy consumption and ease of maintenance.

If a job requires a forced draft tower, provide adequate space for fan shaft removal.

Make provisions to protect the fill from higher temperatures on absorption chiller applications. Indicate in control sequences to shut the chillers and condenser water pumps.

Fan drive(s) should be through drive shafts and gear reducers, with motor mounted outside of the air stream. Include external oil lines and dip stick. The University discourages the use of V-belt drive cooling towers. If V-Belt drives are used, provide non-ferrous sleeves.

Cooling tower fans shall be driven by a variable speed drive.

Refer to “Editor:” notes in the Master Specifications for access platforms and handrails.

Designer shall review need for vibration isolators with the University Project Coordinator.

For winter operation, a remote, indoor sump or tank is preferred (dry cooling tower sump). Where wet cooling tower sump is used for winter operation, provide basin heater and heat tracing for all outdoor piping. Direct steam injection basin heaters are preferred. Used electric sump heater if steam is not available. Heat tracing may be steam or electric.

Cooling tower located on roof shall be supported on roof steel to provide a minimum clearance of 3 feet to the bottom of steel, to enable roof maintenance and replacement.

Acoustic testing and analysis is typically required for all cooling tower installations. Consult Project Coordinator.

Provide accessible basket strainer at inlet to cooling tower.

Designer shall account for derating factors associated with screenwalls, and reentrainment.

Pipe cooling tower overflow/ drain to sanitary waste. Discharge directly to roof is not acceptable.



MECHANICAL SOUND AND VIBRATION CONTROL

General

Sound and vibration shall be carefully evaluated on all projects, for both interior and exterior impacts.

Related Sections

U-M Design Guideline Sections:

[230010 – HVAC Design](#)

U-M Master Specification Sections:

[220548 – Vibration Control](#)

[230593 – Testing, Adjusting and Balancing](#)

Sound Design Requirements

Interior Sound Impacts

Typical space noise criteria levels are listed in Design Guideline 230010. For NC/RC levels not listed in that section, levels shall not exceed those listed in Chapter 46 of the ASHRAE HVAC Applications Handbook (most current addition).

NC/RC levels are a general design criteria only. Spaces where sound is of a special concern, such as large lecture halls, theaters, etc., shall be evaluated using more rigorous criteria based on recognized guidelines. Criteria should be reflected in Design Intent Document and/or in Construction Documents.

For new buildings or major renovations, a study by an acoustical consultant should normally be performed. This study should determine expected sound levels for major space types and, where expected levels exceed established criteria, provide project specific alternative solutions. All significant sound impacts shall be evaluated, not just from mechanical and electrical equipment sources; for example, the impact of a large number of people walking on a hard surface that is located over a more sound sensitive space. For renovation projects, the study should include sample testing of existing areas.

For sound control, low cost solutions are the preference in lieu of more conservative solutions, in particular for spaces without special sound concerns. For instance, the use of acoustical flex duct (not to exceed 5') is preferred over equipping all VAV/CAV boxes with sound attenuators. Noise generating equipment should be located outside of more sensitive areas, i.e. over corridors, when possible, etc.

Duct sound liner shall not be used unless protected by a solid or perforated metal liner. Sound liner protected by perforated metal shall in addition be wrapped with an approved flexible liner. Unprotected duct liner may only be used for short transfer duct applications.

Schedules shall indicate the maximum NC levels (sound power) for terminal boxes, diffusers, lab air valves, and similar equipment. Fan and sound attenuator schedules shall indicate the sound power and attenuation levels required in each octave band. Some levels may be listed for small fans in lieu of octave band levels.

For new buildings or very large renovations, sample sound readings (NC and dBA) for typical spaces should be taken on a post construction basis, to verify if NC levels were achieved. This testing can typically be done by the Test and Balance contractor. More extensive post construction evaluation tests should normally be performed for areas with very special sound concerns, eg. theaters, auditoriums. Further, if these special spaces were renovated, pre-construction sound readings should be taken for comparison to post construction sound levels.

Floating floors should be considered for major mechanical rooms located over sound sensitive areas.

Exterior Sound Impacts

All new construction shall be assessed for exterior sound impacts on surrounding neighborhoods. The normal UM policy is that buildings are not to contribute a perceptible increase to the ambient noise environment. In terms of human perception, a 3 dB change (or less) would typically be considered imperceptible. However the specific characteristics of exterior sound sources shall also be considered, i.e. frequency and reverberant effects, time of day cycling, etc. In no event shall City of Ann Arbor noise guidelines be exceeded. For new buildings or improvements to existing buildings involving the addition of significant sound generating mechanical or electrical equipment to the building exterior, a study by an acoustical consultant should normally be performed. Such studies shall assess sound impacts and, where required to meet the above criteria, provide alternative project specific solutions. Such a study would typically require pre-construction field measurements of existing ambient noise levels to set baselines.

Vibration Design Requirements

Vibration impact and control shall be evaluated for specialized fixed equipment, such as MRIs, as well as building mechanical and electrical equipment.

Vibration Criteria

The maximum allowable vibration levels in the horizontal, vertical, and axial planes for building equipment shall be specified as follows:

Pumps	0.13 in/s RMS
Centrifugal Compressors	0.13 in/s RMS

Fans (all types)	0.09 in/s RMS
Chillers	mfg. recommendation.

Specify that all equipment over ½ HP be field vibration tested. Specify that equipment found to exceed the allowable vibration levels be repaired and retested until within allowable limits, at no cost to the owner.

Vibration Isolation

The minimum vibration isolation required for mechanical and electrical equipment shall conform to the Selection Guide for Vibration Isolation, ASHRAE HVAC Applications Handbook (most current addition).

For spaces with special vibration concerns, eg. clean rooms, theaters, certain medical or research equipment rooms, etc., an acoustical/vibration consultant should be utilized to assess impacts and recommend solutions. During project programming, ambient vibration levels should be recorded if vibration sensitive equipment is planned for buildings adjacent to significant vibration sources, i.e. heavily traveled roads. The results of these tests may dictate that special isolation be provided to accommodate sensitive equipment.

Unless specifically waived by the U-M design coordinator, large pumps and fans installed above grade shall be specified with inertia bases.

Avoid the blanket specification of expensive spring type vibration hangers for piping and duct. Typically when flexible connectors are employed at duct/pipe connections to equipment and the equipment base is properly isolated, spring hangers are only recommended for the first two hangers.



TESTING, ADJUSTING, AND BALANCING

General

This design guideline describes use of U-M's Test Adjust and Balance (TAB) specification, TAB design considerations, minimum TAB data to be shown on design documents, and the contracting of TAB work.

Related Sections

U-M Design Guideline Sections:

[230030 Laboratory Ventilation Design](#)

U-M Master Specification Sections:

[230593 Testing, Adjusting, and Balancing](#)

[230910 Lab Air Flow Controls-DDC](#)

[230920 Lab Terminal Air Flow Units & Controls](#)

TAB Specifications

U-M Master Specification Section 230593 Testing, Adjusting, and Balancing shall be used as the TAB specification on all projects. The A/E shall edit U-M TAB spec. 230593 to make it project specific. Turn on hidden text and read all spec. editors notes when editing the specification.

Pay special attention to the following when revising the spec. to make it project specific:

- Scope of Work Section: Remember to include systems such as domestic hot water return, RO/DI, and process cooling water systems, if TAB work is required on such systems.
- Acoustical Testing Section: Describe the requirements for any needed special acoustical testing. This section also requires sound readings be taken in 6 rooms designated by the AE. It is recommended this requirement always be left in the spec. in case any noise trouble shooting is needed after construction is complete.
- Performance Testing Section: If required, include specific details regarding the tests required.

Review and edit as appropriate, the balancing procedures included in the specification, and add any additional procedures required for unique or complex systems (e.g. BSL3 labs, clean rooms, etc.). If requested by the construction team, participate in the pre-balance conferences described in the spec. to explain the design intent and answer questions about the appropriate TAB procedures.

Be aware that the U-M TAB spec requires submittals relative to the TAB work, including proof of TAB technician qualifications, TAB instrument type and calibration, and proposed reporting forms. The AE must approve these submittals prior to any TAB work commencing.

The U-M TAB spec. requires equipment vibration testing for all rotating equipment ½ HP and larger. If a project is limited to one or two pieces of small horsepower equipment in low risk areas such testing becomes cost prohibitive and the AE should strike it from the spec. Vibration testing should always be included on projects with large equipment or significant rotating equipment quantities.

Note that the U-M TAB spec does not cover ASHRAE 110 fume hood testing.

Note that the U-M TAB spec requires that progress TAB reports be submitted within 3 days and final TAB reports within 1 week of the completion of TAB field work.

Pre-Construction TAB Work

When appropriate, require the TAB trade to perform pre-construction and post-construction TAB work, in particular when spaces are renovated, to measure representative flows, pressures, and/or temperatures of other areas served by common systems. In some cases it may be appropriate to issue a separate contract for pre-construction TAB work.

TAB Design Documents

All required TAB data shall be clearly indicated on the design documents, including the following:

- Code minimum outside air CFM for each air handler
- Air handler supply fan/ return fan/exhaust fan CFM offset (as it relates to building pressurization)
- Dirty filter pressure drops
- Fume hood face velocity alarm point
- Room pressure offsets for rooms designed with CFM offset. Indicate the amount of offset (in CFM) with an arrow pointing in the appropriate direction, across each of the room's doors. Note that the U-M TAB spec. requires smoke-stick tests to validate the offset direction at these room types
- Room pressure offsets for rooms controlled to a setpoint (e.g., to an inches w.c. setpoint) (list on control drawings).

The scope of the TAB work shall be clearly delineated in the design documents. As appropriate, require that the entire system in a renovation project be rebalanced, in particular to assure un-renovated areas are not adversely affected by new work. Include the TAB data for both the new and unaltered portions of the system.

Note that proper architectural patching of room penetrations will be required for any room with pressure offset. The mechanical engineer is advised to assure the project documents thoroughly cover this requirement.

TAB Contracting

The University of Michigan limits TAB work to pre-approved contractors. These contractors are listed in the U-M spec. The AE shall not add or delete from the contractors listed in the spec. unless directed otherwise by U-M.

The preferred and best practice is for the TAB trade to be under contract direct to the Owner rather than as a sub-contractor to another trade. Discuss the TAB contracting arrangement with the U-M Project Manager and prepare bid documents as directed.

Air and water balance should always be done by the same TAB contractor, and is a requirement of the U-M TAB spec. If a project is so large that multiple TAB contracts are required, the scope of work split should be by building area, with one contractor doing all air and water balance for a specific area, and for all systems that serve that area. Splitting all air to one TAB contractor and all water to another TAB contractor significantly dilutes the efficacy of the TAB procedures and is never advisable.



MECHANICAL SYSTEMS CONTROLS

Related Sections

U-M Design Guideline Sections:

[230030 - Laboratory Ventilation Design](#)

U-M Master Specification Sections:

[230900 - Mechanical Systems Controls](#)

[230910 - Lab Air Flow Controls-DDC](#)

[230920 - Lab Terminal Air Flow Units & Controls](#)

U-M Standard Details:

[15975001 - Differential Pressure Transmitter Installation Detail \(Liquid\)](#)

[15975002 - Typical DDC Panel Assembly](#)

General

This Design Guideline does not apply to laboratory and fume hood air flow controls; see Design Guideline 230030 for these systems.

Direct digital controls (DDC) are the standard for control at U-M. Pneumatic or other non-DDC controls are limited to very small systems and shall only be specified with the Design Manager's permission.

U-M Master Specification Section 230900 Mechanical Systems Controls shall be used as the controls specification on all projects. The A/E shall edit U-M Master Specification 230900 to make it project specific. Turn on hidden text and read all spec. editor's notes when editing the specification.

Note that generally the U-M controls specification should only have items *added to it* to make it project specific (e.g. a meter which is peculiar to the project and not already covered in the spec.), otherwise it is recommended that the A/E *not* delete materials or devices from the specification.

Exception: If the typical work scope split described below under "U-M vs Contractor Work Scope" is *not* to occur, the A/E will need to edit Part 1 and 3 of the specification to make the work scope split specific to the project. While rare, such editing may be required for certain non General Fund auxiliary unit projects such as for Athletics. Consult the U-M Design Manager.

U-M has an extensive Building Automation System (BAS) that networks to localized DDC controls. This system utilizes propriety Siemens components as well as non propriety generic controls. UM has negotiated pricing for the proprietary components and purchases

these direct from Siemens for projects. U-M also self performs a portion of the DDC control work. Project budgets must (also) include the cost of the proprietary components and U-M's self performed work. During budget planning, the U-M Design Manager will provide information regarding how these costs are to be accounted for in the budget.

U-M vs Contractor Work Scope

The A/E should consult the first few pages of U-M Master Specification 230900 for detailed information regarding the split of control work, university versus contractor. By utilizing U-M's control specification, proper work scope split occurs automatically and is essentially transparent to the A/E design effort. Note that non General Fund auxiliary units may handle controls differently; always consult the Design Manager. In general, the split is as follows:

University of Michigan: Provides proprietary DDC panels, terminates inside these panels, and programs and starts-up the DDC panels. Provides application specific terminal equipment controllers (TECs) for contractor installation (e.g. DDC VAV box controllers) and room sensors for TECs.

Contractor: Supplies and installs: all field devices (transmitters, actuators, control valves, control dampers, transducers, etc.), all control wiring and tubing, all auxiliary control panels, and prepares a complete controls submittal. Mounts U-M supplied DDC panels. Installs TECs and TEC room sensors.

The detail "Typical DDC Panel Assembly" provides a graphical representation of the work split.

Using U-M Master Specification 230900

The A/E shall use U-M Master Specification 230900 as the basis for the control specification and edit it to make it project specific.

When editing this spec, assure hidden text is tuned "on" and carefully review all spec editor's notes.

Special attention should be paid to the following articles:

- Article 1.3: Edit the list of acceptable controls contractors in consultation with and as approved by the Design Manager.
- Article 2.2: Obtain approval for the type of steam condensate meter to be used, and then edit the spec accordingly.
- Article 2.3: U-M supplies application specific TECs for DDC terminal (VAV, CAV, etc.) boxes. The controls contractor is responsible for mounting these TECs on the boxes. The A/E must edit his specification for such boxes to assure the box manufacturer only supplies the components listed in article 2.3 (e.g. pneumatic damper operator and air flow arrays), NOT DDC controllers. *On the rare occasion pneumatic VAV box controllers are used, specify that the box manufacturer provide a Krueter model CSC-3011 controller, a normally open damper, and a damper operator.*

- Article 2.6: If electrical actuators are used, power for these actuators must be accounted for on drawings. Read the spec editor's note in this article for further direction.

The U-M master specification includes specifications for most types of control components. In some cases the A/E will need to add supplemental specifications for atypical components.

Control or automatic dampers (actuated dampers) are specified in Master Specification 230900. The A/E's specification should include no other control damper specifications, and specification sections requiring factory provided control dampers, e.g. air handler specifications, shall reference Master Specification 230900 for the control damper spec.

Control Drawings

The required scope of a project's controls shall be indicated by the use of control drawings. Each control drawing shall include a detailed sequence of operation.

Control drawings and sequences shall appear on the mechanical drawings; they shall not appear in project specifications.

Control drawings shall utilized U-M's standard controls symbology. Normally, U-M will provide sample control drawings in electronic format for A/E use, which will include sequences of operation. Revise these drawings to make them project specific. Revise sequences of operation to include strategies specific to the project (example: change-over to free cooling). Include all project specific setpoints and alarm values. Provide similar control drawings for systems not available from U-M's samples.

Wiring diagrams shall be provided on the control drawings that indicate the method of starting fans, pumps, and other equipment, safety interlocks, interface to manufacturer's provided controls, etc. These diagrams may be schematic in nature but shall indicate fundamentally how electrical control is accomplished.

"Point Lists" are not required and shall not be used.

DDC Panel Locations, Clearances, and Communication Wiring

The control drawings shall include system architecture diagrams specific to the project. These diagrams indicate the location and quantity of DDC and auxiliary panels. U-M will normally provide this information to the A/E, for inclusion on the project drawings.

The controls contractor will run all communication wiring between DDC panels and TECs. Communication wiring is to be indicated on the system architecture diagram, including wiring back to a telephone closet.

Each DDC panel will have one or more auxiliary panels. See "Typical DDC Panel Assembly". The A/E shall indicate the location of these panels on the plan views. For a typical assembly allow 7' of wall space; note that some panel assemblies require more space, consult with U-M. Locate panels to provide a minimum of 36" clearance in front of each panel, and designate this clearance on the drawings.

Power for Controls

DDC Panel Assemblies: Each assembly (not each panel in an assembly) shall be provided with (2) 20 amp dedicated circuits (separate circuit breakers). Indicate these circuits on the electrical drawings, home-run to the panel assembly location.

TEC Power (DDC VAV box controllers, etc.): Designate circuits in receptacle panels on each floor for TEC transformers. Provide one 20 amp circuit for every (50) Terminal Equipment Controllers.

Actuator Power: See Master Specification 230900, Article 2.6.

Power for meters and other control accessories that are provided by the controls contractor: This is provided through a fused disconnect located in the DDC auxiliary panel and is part of the controls contractor's scope of work per U-M Master Specification 230900. Therefore the A/E does not need to typically indicate power for such items on the design drawings. See U-M Master Specification 230900, article 2.5.

Life Safety Control

U-M's DDC system is not listed for life safety use and therefore shall not be used for initiating or alarming life safety applications. Two common examples are as follows:

Stair Pressurization Control: The building fire alarm system will initiate operation of the stair pressurization fans. Any controls required for stair pressurization shall be stand-alone from (and independent of) the DDC system.

Atrium Smoke Purge: The building fire alarm system will initiate atrium smoke purge. Any controls required for smoke purge shall be stand-alone from (and independent of) the DDC system.

However, the controls contractor will provide the stand alone components (dampers, end-switches, pressure transmitters, etc.) and therefore these components shall be indicated on the control drawings and include complete sequences of operation.

Manufacturer Provided (Packaged) Controls

Chillers and boilers shall be equipped with manufacturer provided controls. Manufacturer provided controls shall typically be limited to control of the chiller (boiler) itself. Control of the chiller (boiler) plant (chiller (boiler) sequencing, etc.) shall be by U-M's DDC system.

Packaged controls should also be specified for equipment normally equipped that way, such as storm/sanitary pumps, RO/DI systems, vacuum pumps, air compressors, pollution control (air and water treatment) systems, refrigerant leak detection, fuel oil systems, DX systems, condensate pumps, etc. See the respective design guideline for these systems for any specific requirements for the packaged controls.

Packaged controls shall not be specified for air handlers, unless specific permission is given by the U-M Design Manager.

Control Air

For central campus projects, 90 PSIG compressed air is available from the campus steam tunnel system at minus (-) 50 °F dewpoint. This air shall be utilized for control air use, dryers for control air are not required.

For other campus locations, a control air compressor will normally be required. U-M Master Specification 230900 specifies control air compressors and accessories (PRV stations, refrigerated air dryers, etc.).

In either case, A/E drawings shall indicate the source of control air.

Electric vs. Pneumatic Actuators

Damper actuators and large control valves shall be pneumatically actuated, except for special conditions as approved by the U-M Design Manager. Small dampers and valves controlled by TECs shall utilize electric actuators, as indicated in U-M Master Specification 230900.

Smoke and combination fire/smoke dampers shall be pneumatically actuated.

Typical Alarms to be Monitored by DDC

In addition to the typical status alarms associated with DDC control, the DDC shall be indicated as monitoring the following equipment. Equipment should be specified with a common alarm contact for DDC monitoring, not separate alarm contacts for each alarm condition, except as noted:

- Sanitary and Storm Pumps (common alarm: high level, seal failure, etc)
- Cold/Warm/Environmental Rooms
- Walk-in Freezers
- Heat Trace
- Emergency Generator (generator running, generator trouble)
- Automatic Transfer Switch Transferred to Generator Power (Connect in series each “on generator power” auxiliary contact in each ATS to a single point in a DDC panel to notify BAS if any ATS transfers to generator power.)
- Critical Unitary A/C units (for example, computer rooms)
- RO/DI Systems
- Pollution Control Systems
- Fuel Oil Systems
- Refrigerant Leak Detection Systems
- Chiller Relief Valve Status
- Domestic Water Booster Pump Systems

- Glycol Make-up Systems (separate low pressure and low level alarms)
- Substation Room Temperature

The above list is not exhaustive. The design team shall carefully consider and include alarm monitoring appropriate for the project. *The A/E shall indicate any special alarm setpoints on the control drawings* (e.g. critical humidity limits in a clean room or museum).

Miscellaneous

DDC controlled heating hot water heat exchangers shall include back-up pneumatic control.

DDC controlled cooling towers shall include a pneumatic controller to provide back-up control of the tower condenser water bypass valve arrangement .

Exterior lighting associated with new buildings shall be controlled by DDC. DDC shall turn the lights on and off, and status the lighting contactor (via a current sensing relay). The contract drawings shall indicate a contactor for exterior lighting control by DDC.

U-M utilizes a central weather station that transmits outside temperature and humidity conditions across the BAS network. Therefore local outside temperature and humidity transmitters should normally not be indicated.

Fan systems capable of developing static pressures in excess of the duct system's (air handler casing, plenums, ducts) static pressure rating (positive or negative) shall be equipped with static pressure safeties to turn off the fans prior to damage occurring from excessive pressure. The AE should not indiscriminately specify these devices but shall include them based on an evaluation of the maximum pressure the fan can develop, the pressure class of the duct system, damper pressure ratings, and the degree of risk.

In general, for air handlers, heating coils shall be designated as fail open, and cooling coils shall be designated as fail closed.

For reheat coils in zones serving animal rooms, reheat coil control valves shall be **normally closed** type. This avoids a wild coil condition from severely over-heating the animal room.

Include U-M's "Differential Pressure Transmitter Installation Detail (Liquid)" on any project utilizing liquid DP transmitters.

For all air and liquid flow measuring devices, the AE shall indicate their location on the plan views as well as on the control drawings. Design the duct or piping at the meter location to provide the manufacturer's required up and downstream straight and unobstructed lengths, and indicate these requirements on the drawings. When in doubt as to specific manufacturer's requirements, provide 10 straight diameters upstream and 5 straight diameters downstream.



REFRIGERANT MONITORING SYSTEM

General

Provide a refrigerant monitoring system in accordance with ASHRAE 15-1994.

Designer to select either remote sensing (CHILLGARD-RT) or point of use sensing (CHILLGARD-L Series) system for refrigerant monitoring and alarm.

Designer to provide a system of fans and dampers to sweep the room with fresh air and exhaust to clear the room of refrigerant.

Designer to verify numbers of doors and lights required.

The supply, exhaust fans and related dampers shall be activated through hard wiring from the refrigeration monitor control panel. Provide an input to DDC system to indicate alarm condition.

No SCBA is required since U-M has a 24/7 emergency response team with trained personnel properly fitted for SCBA.

If any of the fans are driven by VSD, same shall be equipped with a bypass. Hardwire VSD to go into full speed on alarm condition.



STEAM SPECIALTIES

General

Consult with Project Coordinator whenever the quality of the steam is an issue to the A/E. See University Provided Utilities in the SID Section for steam pressures available.

Design Requirements

Where medium pressure steam (60 psig) is available, a pressure reducing station shall be provided to meet the total low pressure (5 psig) load during major breakdowns or planned maintenance.

Where intermediate steam pressure is required (e.g. 15 psig) a jet compressor should be provided to supplement the low pressure steam.

The pressure reducing valve or jet compressor should be insulated and covered with sound attenuation wrapping.

Equipment Requirements

Traps, Strainers and Meters

Float and thermostatic traps - F & T traps should have heavy cast iron bodies. The float valve mechanism should be of heavy brass and should have a variable level action to ensure quick and full opening.

The thermostatic bellows member for venting air should have not less than 10 corrugations and should be protected against damage from water hammer by a brass shield cup.

Inverted Bucket Traps - IB traps should have high-strength cast iron bodies. Bucket should be of brass and the level mechanism should be of heat treated stainless steel operating on knife edges. Removable seats and plungers should be heat treated stainless steel. Steam tight seal between seats and covers should be provided using an automotive type copper gasket.

A vertical tube should be threaded into the inlet opening and capped with a baffle to prevent condensate from impinging on the bucket.

Strainers - Strainers should be of the 'Y' type having heavy cast iron bodies with blow-off tapings in screen covers.

Sizes 1/2 inch through 1-1/2 inches should have a screen of 20 mesh Monel.

Sizes 2 inches and over should be .016 inch thick perforated stainless steel, with 324 holes 1 per square inch, each .033 inch diameter.

Steam and Condensate Meters - Where possible all steam shall be metered by gravity type condensate meters as manufactured by CADILLAC METER CO., or as approved by the University Utilities Engineer through the University Project Coordinator. Flashtanks shall be provided before the meters.

Medium pressure steam that will not be returned as condensate shall be metered directly with an orifice plate and a calibratable, differential pressure cell and transmitter with pressure compensation. "Shunt flow" or by-pass type steam meters are not acceptable.

Meters should be complete with a low voltage pulse totalizer output and a 4-20 mA output proportional to flow where appropriate for external interface with a building management system.

Steam Humidifiers

Humidification should be normally provided for each project. If required, primary humidification at the central AHU's will be provided after evaluating problems that may be caused by condensation on the perimeter glazing.

When a specific zone requires a higher humidity level than adjoining areas, the A/E should provide for the prevention of moisture migration from this high humidity zone. This will require that doors remain closed except for individual ingress/egress for Rh differentials approaching 20 percent and non-permeable floor/wall/ceiling treatment for greater differentials.

All steam humidifiers connected to the building steam supply, whether primary or secondary, should contain insulated dispersion tubes.

Installation Requirements

Size traps for twice the condensate rating unless the coil or vessel manufacturer recommends otherwise. Install multiple traps where one trap will not handle the condensate rating.

The run-out from unit being trapped should be the same size as the drain tapping.

The discharge line downstream of the pressure reducing valve or jet compressor shall be fitted with a pressure relief vented to atmosphere (outside the building) to prevent overpressurization of equipment and components.

Install strainers ahead of all controlled devices. Install a valved blow-down line for each strainer. Screens should be removable without disturbing the pipes.

Install inverted bucket traps on all steam equipment drains and all steam line condensate drains except for steam using equipment served by modulating steam control valves. For this equipment, install float and thermostatic traps.

Humidifiers to be located to assure absorption into the airstream rather than wetting of parts such as fans, turning vanes, etc. The preferred location is in the supply ductwork, with 10-12

feet of straight duct downstream. Internal lining should not be used downstream within 10 feet of humidifier.



COMMON WORK RESULTS FOR ELECTRICAL

Scope

Prepare the project's electrical design and associated contract documents in accordance with these Design Guidelines, in accordance with the scope of work defined in the Program Documents, and within the construction budget.

Related Sections

U-M Design Guideline Sections:

[Special Instructions to Designers](#)

[Special Building Areas](#)

[Division 26 - Electrical Technical Sections](#)

[Electrical Trades Preferred Manufacturers List](#)

[Design Deliverables](#)

U-M Master Specification Sections:

[Division 01 - General Requirements](#)

[Division 26 - Electrical Master Specifications](#)

[Division 27 - Communications](#)

[Division 28 - Electronic Safety and Security](#)

U-M Standard Details:

[260000 Series - Electrical Standard Details](#)

Reference Documents:

NFPA 70E – Standard for Electrical Safety Requirements for Employee Workplaces

Design Requirements

Submit the documents specified in the Design Deliverables list for approval. Submit them at the end of the Schematic Design, Design Development and Construction Documents phases.

Design the power distribution system such that the arc flash hazard Personal Protective Equipment (PPE) required to examine, adjust, service or maintain equipment while energized is Category 4 or less at unit substations and switchboards, and Category 2 or less at panelboards and similar equipment.

Provide flexibility for future changes in the use of the space, and provide spare capacity for future load growth. Provide 20 percent spare capacity for load growth unless 20 percent spare capacity would require a significant power distribution system upgrade. In those special cases, provide as much spare capacity as the existing system can supply.

Field verify the existing installation and/or site. Do not rely solely on the existing drawings and/or site surveys. As a minimum, field verify the quantities, sizes, ages, conditions and spare capacities of the following:

- Power ducts, manholes, services to the building and unit substations.
- Panels, circuit breakers, disconnect switches, motor controls, raceways and wiring.
- Interior and exterior lighting, switches and receptacles.
- Grounding.
- Telecommunications ducts, manholes, rooms and services to the building.
- Fire alarm, security, card access control, audio/visual and other special systems.

Coordinate with the Design Manager to obtain recent historical information from the following U-M departments:

- Key plans and electrical risers from AEC.
- Electrical usage, primary system and unit substation information from the Plant Utilities and Plant Engineering (UPE) Department.
- Existing condition information from the Facility Condition Assessment Program, the Facility's Manager and the Plant Region maintenance personnel.
- Fire alarm and security system information including fire alarm drill results from the Plant Fire Protection Shop and the Department of Public Safety and Security.
- Card access control system information from the Plant Key Office.

Show all known below grade, below floor and in-floor utilities that will be impacted by the project's work.

Use existing spare circuit breakers or existing spaces whenever possible. If necessary, combine existing lightly loaded circuits to free existing circuit breakers for the new loads. Tap buses only with the approval of the Plant UPE Department. Coordinate with the Design Manager before adding a new unit substation.

Number electrical panels and devices in accordance with U-M Standard Detail 260500001.

Match the existing installation whenever possible and practical.

Locate equipment requiring routine maintenance so it is easily accessible.

- Installations shall not require the use of a lift or scaffolding, or the removal of other infrastructure, for routine maintenance.
- For rooftop equipment with control panels, motor starters, disconnects or motors mounted over 6 feet above roof level and requiring routine maintenance, arrange for the Architect to provide a permanent galvanized steel work platform and ladder.

Provide access panels (24 inches square minimum to access equipment out of arm's reach) for maintaining electrical equipment located behind walls or above permanent ceilings.

Ensure that no piping or ductwork is routed in the NEC-required dedicated spaces above or working spaces around electrical equipment. Provide drip pans for existing piping routed over electrical equipment.

Correct code violations and safety hazards to the greatest extent possible within the project boundary. If existing code violations or safety hazards are discovered that are not addressed in the Program Documents, notify the Project Manager.

Short Circuit, Protective Device Coordination and Arc Flash Hazard Studies

On projects providing a new or replacing an existing power distribution system, perform a preliminary power distribution system short circuit and protective device coordination study to establish the project's electrical equipment ratings.

- Include in the study the project scope plus existing electrical infrastructure affected by and coordinating with the project scope.
- Verify electrical equipment supplied by others such as inverters, chiller control panels and variable speed drives are adequately rated for the available short circuit current.
- Non-fusible disconnect switches are only rated 10kA symmetrical. Where the available short circuit current exceeds this amount, specify fused disconnect switches.
- When the power distribution system includes an interactive power source such as an engine-generator with closed transition or soft-loading automatic transfer switches, solar photovoltaic system, wind generator or fuel cells, perform the short circuit study twice. First, use only the fault contribution from the incoming utility power system or from the interactive source, whichever contribution is greater. Secondly, combine the fault contributions from the incoming utility power system and interactive source to get the worst case situation. Submit the results of both studies.
 - Use the first study to establish the electrical equipment ratings when the interactive power source will be paralleled only momentarily with the incoming utility power system, such as when the interactive source is an engine-generator with closed transition transfer switches.
 - Use the second study to establish the electrical equipment ratings when the interactive power source will be paralleled more than momentarily with the incoming utility power system.
- Submit the study for review at the end of Design Development.

Perform or arrange for a Registered Professional Engineer to perform a final power distribution system short circuit, protective device coordination and arc flash hazard study. The Electrical Contractor shall not perform or arrange for this study.

- Include in the final study the project scope plus existing electrical infrastructure affected by and coordinating with the project scope.
- Perform the final study in accordance with applicable ANSI/IEEE standards using computer software from SKM Power Tools. Perform the arc flash hazard study in accordance with NFPA 70E.
- The final study shall be performed by an Engineer with extensive experience in the performance of these studies. The study shall be signed and sealed by a Registered Professional Engineer in the State of Michigan. If performed by other than the Architect/Engineer, the Architect/Engineer shall review and approve the study.
- When the power distribution system includes an interactive power source, perform the final short circuit study twice as was done for the preliminary study. Submit the results of both studies.

- Use the first study to establish the fuse sizes, protective device settings and arc flash hazard values when the interactive power source will be paralleled only momentarily with the incoming utility power system, such as when the interactive source is an engine-generator with closed transition transfer switches.
- Use the second study to establish the fuse sizes, protective device settings and arc flash hazard values when the interactive power source will be paralleled more than momentarily with the incoming utility power system.
- The final study shall incorporate shop drawing information and protective device coordination time-current curves from the electrical equipment manufacturers, and actual cable sizes and lengths from the Electrical Contractor.
- Summarize the results of the final study in a report.
 - Identify electrical equipment that is inadequately rated or that does not coordinate with upstream equipment.
 - Specify fuse sizes and protective device settings in table format.
 - Specify automatic transfer switch voltage, current, time and control settings in table format.
 - Specify arc flash incident values, working distances, arc flash boundary distances and Personal Protection Equipment (PPE) levels in table format.
 - Provide phase and ground fault coordination time-current curves showing the selective coordination of the substation secondary main, tie and feeder breakers with downstream protective devices. Include transformer, large motor and feeder conductor damage curves.
- Submit the study and report to the Owner and Commissioning Authority for approval prior to equipment energization.
- Submit the report to the Electrical Contractor for their use in providing fuses and adjusting electrical equipment settings prior to equipment testing and energization. The independent electrical testing agency and Commissioning Authority will verify proper fuse sizes, protective device settings and automatic transfer switch settings.
- Submit the completed SKM Power Tools data files on a CD or DVD for use by the Owner during future system modifications.

Arc Flash Hazard Warning Labels

The Electrical Contractor shall provide generic arc flash hazard warning labels on equipment shown by the final report to have an arc flash incident energy level exceeding 1.2 calories/square centimeter and likely to require examination, adjustment, servicing or maintenance while energized. This includes but is not limited to automatic transfer switches, switchboards, panelboards, meter socket enclosures, transformers, storage batteries, battery chargers, inverters, control panels, variable speed drives, motor controllers, circuit breakers and disconnect switches. Two labels (line side and load side) are to be provided on fused disconnect switches and circuit breakers 800 amps and above, and on the primary and secondary sides of transformers.

- Contractor-provided labels are not required on primary switchgear or unit substations. U-M Plant Operations will provide device-specific labels on this equipment.

- Contractor-provided labels are not required on equipment that is factory labeled by its manufacturer.

Although portions may be energized early to provide temporary power for construction, the power distribution system will not be declared Substantially Complete and will not be accepted by the University until the study and labeling tasks have been completed.

Design Drawings

Prepare the following electrical drawings and specifications in accordance with the Design Deliverables list and as applicable to the project, for use during construction:

- Demolition plans and details.
- Underground duct bank and manhole plans, elevations, profiles and details.
- Primary and secondary feeder conduit routing drawings.
- Normal and emergency power plans, one-lines, risers and details.
- Schematic and wiring diagrams.
- Lighting plans and details.
- Telecommunications, fire alarm, clock, card access control, security, CCTV, audio/visual, sound reinforcement and other special systems plans, risers, schematics, and wiring diagrams.
- Grounding and lightning protection plans, risers and details.
- Substation, switchboard, panelboard, MCC and other applicable equipment schedules.
- Systems and equipment sequences of operation.

For new electrical drawings, use the symbols and abbreviations established by the applicable nationally recognized trade association. When revising existing drawings, use the existing symbols and name equipment using the existing convention. Provide a complete symbols legend.

When revising existing drawings, identify revisions. Circle and label revisions, or draw the revisions using a heavier line weight than used for the existing and background.

When a building feature, cable tray, conduit, or circuit continues on to another drawing, reference the continuation drawing at the point of continuation. Show reference column and row numbers for clarity.

On new building, building addition and total renovation projects, facilitate the use of aluminum cables in lieu of copper for feeder circuits No. 1 AWG and larger only. On partial renovation projects, match the existing cable type. Note that chiller manufacturers will not allow the use of aluminum cables to feed chiller VSDs or starters.

- Provide two cable and conduit sizing charts on the drawings, one for copper cables and one for aluminum cables.
- Include the aluminum cable technical and installation requirements contained in Master Specification 260513. Include Standard Detail 16120013 on the drawings.
- After completion of construction, verify the as-built drawings identify where aluminum conductor cables were installed.

Show the wire and conduit sizes for every feeder circuit on the riser and one-line diagrams.

Show wire and conduit sizes on the plan drawings for any circuit other than 20 amperes, single phase. Show multi-wire feeder and branch circuits requiring separate or oversized neutrals. A general note is adequate to define wire and conduit sizes for 20-ampere single phase circuits and to specify shared neutrals.

Show bus amperes, number of phases and wires, breaker/starter/fused switch/fuse sizes, and AIC ratings for all unit substations, switchboards, panels, MCC's, etc.

Specify the mounting heights of electrical devices. Indicate if the devices are flush or surface mounted. Indicate if raceways are exposed or concealed. Show 4" high minimum concrete housekeeping pads for floor-mounted equipment.

Show Contractor furnished electrical equipment and control wiring on the plan drawings. Include equipment required by the NEC such as motor disconnect switches if not provided by others, and include control wiring required for equipment operation if not provided by others. Do not rely solely on specification statements or general drawing notes to identify Contractor scope. Provide sufficient information so that quantities can be determined easily.

Specifications

Number specification sections in accordance with the CSI specification numbering system.

Use the U-M Master Specification sections applicable to the project. Turn on hidden text, follow the hidden text editor's notes and edit the sections to make them project specific.

Eliminate from general specifications the requirements that do not apply to the project.

Shop Drawing Review

Review Contractor submitted shop drawings and product literature. Approve submittals that comply with the contract documents, and mark up or reject submittals that do not comply. Approved submittals shall include adequate information to prove that the proposed products comply fully with the contract documents. Each copy shall be marked to indicate the specific models, sizes, types and options being provided. Submittals not so marked shall be rejected.

Testing

Specify testing in accordance with Design Guideline 16950. Request approval before specifying testing beyond what is listed in Design Guideline 16950.

Commissioning

Insert Commissioning Master Specification 019100 or 019110 into the project specifications and edit it to make it project specific (unless an edited version will be provided by the U-M Commissioning Authority during CD design). Refer to this specification section rather than specifying commissioning requirements in the other specification sections.

Operation and Maintenance Manuals

Edit and insert Master Specification 017823 into the project specifications. Refer to this specification section rather than specifying O&M manual requirements in the other specification sections.

Review and approve Contractor submitted operation and maintenance manuals. These manuals shall be marked to indicate the specific models, sizes, types and options of the systems and equipment that will be provided. Manuals not so marked shall be rejected.

Training

Refer to Specification 017823 when specifying Owner training requirements. Training shall not take place until the Owner's Personnel have been given 2 weeks to review the approved Operation and Maintenance Manuals. The Contractor shall notify the Project Manager 3 working days in advance of training sessions.

Record Drawings

Review and approve Contractor submitted as-built information and provide the information to the University in accordance with SID-H, "Construction Documents". The drawings shall show the locations of equipment, light fixtures, switches, receptacles and junction boxes, riser information, the sizes of conduits and conductors, circuit numbers, and deviations from the design. Buried, embedded and concealed primary and feeder conduits shall be dimensioned from permanent building features.

Products

Specify products that conform to the applicable standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), the National Electrical Manufacturers Association (NEMA) and the National Fire Protection Association (NFPA).

Specify that products be listed or labeled by a Nationally Recognized Testing Laboratory. When components are combined to form a major assembly, the entire assembly shall be listed or labeled.

Specify multiple manufacturers from the Electrical Trades Preferred Manufacturers List when multiple manufacturers produce products meeting the project requirements.

Do not use the term "Or Equal" or any similar language to specify products or services.

Specify products that are known to have been used with success elsewhere. Do not specify newly developed or unproven products.

When designing new electrical systems, specify major power distribution equipment shall be from one manufacturer. When designing renovations, match the existing equipment where practical.

Specify that equipment and materials shall be provided from the manufacturers specified. Substitutions for specified products shall be acceptable only if proposed and approved in writing before the project is awarded.

During Contractor shop drawing submittal review, approve only those submittals which comply with the project specifications.

Execution

Ensure the following additional Contractor actions are specified in the contract documents.

Temporary Services

Temporary lighting and power shall be provided as specified in the project's Supplemental General Conditions.

Permanent electrical systems or equipment used during construction shall be replaced or cleaned and fully refurbished prior to acceptance by the University.

Electrical Coordination

The Contractor shall participate in the specified project scheduling and coordination drawing activities as specified in Division 1 of the project specifications.

The Contractor shall notify the Project Manager of power interruptions 3 working days in advance, and shall maintain power to loads outside of the work area.

The Contractor shall coordinate with the Plant Operations Call Center at (734) 647-2059:

- Before performing any work affecting primary power distribution circuits, unit substations or exterior lighting.
- Before performing any work affecting engine-generators or variable speed drives.
- Before performing any work affecting fire alarm, security or card access control systems.
- Before performing any work affecting telecommunications ducts, manholes or rooms.
- Before performing any work affecting roofs.

The Contractor shall notify OSEH at (734) 647-1143 before starting up engine-generators.

The Contractor shall coordinate work with the other trades to ensure the NEC-required dedicated spaces above and working spaces around electrical equipment is provided, and to ensure access to equipment requiring calibration or maintenance. Working space and access shall be sufficient for an adult to perform maintenance safely without straddling or removing obstructions. Work that encroaches on working space or that impedes maintenance shall be relocated at the Contractor's expense.

For deliveries of equipment to the Owner, the Project Manager shall be notified 3 working days in advance. Deliveries shall occur on normal workdays between 8:00 AM and 2:00 PM. Deliveries that arrive without adequate notice may be rejected.

Owner furnished equipment that is shipped to the project site shall be unloaded and stored by the Contractor. Owner furnished equipment that is stored in the Owner's warehouses shall be picked up, transported, unloaded and stored by the Contractor at the project site.

Demolition

Equipment and materials designated for demolition shall be removed as follows:

- Power wiring: Remove back to the source or to the first junction box where the circuit continues on to remaining loads.
- Telecommunications wiring: Remove from conduits and J-hooks back to cable trays or to the outer walls of telecommunications rooms. U-M ITSComm personnel will remove abandoned wiring from cable trays and inside the telecommunications rooms.
- Conduits and boxes in walls and above permanent ceilings: Abandon in place. Install blank cover plates on boxes.
- Conduits through floors and walls, and boxes in floors: Remove completely. Patch and paint penetrations to match existing.
- Exposed and accessible conduits, wireways and boxes: Remove completely. Patch and paint surfaces to match existing, and plug unused panel and junction box holes.
- Lighting fixtures and electrical equipment: Remove and dispose of completely (unless designated for relocation).

Items designated for relocation shall be cleaned and restored to a "like new" condition.

Lamp and Ballast Recycling

The Contractor shall recycle lamps and ballasts. Insert verbatim into the project specifications the recycling requirements contained in Master Specification 16010.

Quality Assurance

Electrical work shall be performed by licensed Journeyman or registered Apprentice Electricians. The number of Apprentices on a project shall not exceed the number of Journeymen. Electricians shall carry a copy of their license or registration while working on University projects.

The Contractor shall contact the Owner's Code Inspection Department at (734) 764-2457 before the start of the project to arrange for periodic inspections. Normal inspections will be performed at no cost to the Contractor, but the costs for repeat re-inspections of rejected work may be deducted from the Contractor's final payment.

Electrical systems, equipment and materials shall be tested by an independent testing agency prior to final acceptance of the work. Acceptance tests shall be performed in accordance with applicable codes, standards and manufacturers' instructions.

- Notify the Project Manager 3 working days in advance of tests. The Owner shall witness the tests unless the Project Manager waives witnessing in writing.

- Notify manufacturers sufficiently in advance of tests for which the manufacturers should be present.
- Provide written test reports, signed and dated, for all tests prior to acceptance of the electrical equipment by the Owner.

Warranty

Electrical work shall be guaranteed for a period of one year from the date of acceptance of the project by the University. A manufacturer's warranty beginning upon equipment receipt or startup shall be extended to one year from final project acceptance. A manufacturer's warranty in excess of one year shall remain in effect for its entire time period.



MEDIUM, LOW AND CONTROL VOLTAGE CABLES

Related Sections

U-M Design Guideline Sections:

[260800 - Electrical Acceptance Tests](#)

Products

Medium Voltage Primary Cables

Primary power distribution cable shall be single conductor stranded copper, with ethylene propylene rubber (EPR) insulation rated 15kV, 90 degrees C, 133 percent insulation level, having a 5 mil thick minimum tape shield with 12-1/2 percent minimum overlap, and polyvinyl chloride (PVC) jacket. Cable shall be suitable for use on a 13.2 kV, 3 phase, 3 wire, ungrounded system. Cable shall be suitable for use in cable trays.

Medium voltage service cables of voltages other than 13.2-kV (2.4kV, 4.8-kV) shall be of the type noted immediately above. The cable and terminations will be provided, and installed, to allow possible, future, conversion of the service to 13.2-kV.

Medium voltage cables serving loads directly at voltages below 13.2-kV (2.4-kV, 4.16-kV, 4.8-kV) shall be single conductor stranded copper, with ethylene propylene rubber (EPR) insulation rated 5kV, 90 degrees C, 133 percent insulation level, and polyvinyl chloride (PVC) jacket. Cable shall be suitable for use on a 5 kV, 3 phase, 3 wire, ungrounded system. Cable shall be suitable for use in cable trays.

Wires and Cables (600 Volts and Below)

Power distribution and lighting wire for indoor use shall be single conductor stranded copper, No. 12 AWG minimum, with NEC Type THHN, or THHN/THWN-2 insulation rated 90 degrees C, 600 volts.

Power distribution and lighting wire for outdoor use, for use in parking structures and tunnels, and for underground use in conduits shall be single conductor stranded copper, No. 12 AWG minimum, with NEC Type XHHW insulation rated 90 degrees C in dry locations and 75 degrees C in wet locations, 600 volts.

Insulated power cable for use as fire pump supply cables shall be able to pass the two hour fire rated test under UL 2196 test (and shall be so labeled), be NEC Type MI rated 600-volts, and shall be one of the following types:

1. Mineral insulated, single conductor, solid copper conductor, using compressed magnesium oxide insulation, and shall have a liquid and gas tight seamless copper sheath. The cable is NEC Type MI. This cable is Factory Mutual (FM) approved, and may be used without need for a 'clearance from FM... Install and support as required by manufacturer and Code.
2. Ceramfied silicone insulated (Lifeline), single conductor, stranded copper conductor, cermafied silicone rubber insulated. The cable to be NEC Type RHH. This cable is not FM approved. FM must review each application before giving an approval for that project. Install cable in EMT, and install and support as required by manufacturer and Code

Control wire shall be single conductor stranded copper, No. 14 AWG minimum, with NEC Type THHN, or THHN/THWN-2 insulation rated 90 degrees C, 600 volts.

Instrumentation and special systems wire shall be in accordance with manufacturer's recommendations, but shall not be less than No. 20 AWG.

Execution

Medium Voltage Primary Cables

Cables shall be pulled in lengths not exceeding 500 feet.

Cables shall be pulled using generous amounts of compatible cable pulling lubricant.

AE shall make calculations to insure maximum cable pulling tensions, sidewall pressures and cable bend radii do not exceed manufacturer's instructions.

Cables passing through manholes shall be trained neatly in the same relative position as in the duct bank, without crossing each other, and shall be supported by porcelain or fiberglass insulators attached to manhole cable racks.

Cables shall be identified by numbered tags. Identification numbers and tagging requirements shall be coordinated with the Plant Electric Shop through the Owner's Representative.

Wires and Cables (600 Volts and Below)

All wiring, including low voltage control, telecommunications, and power limited wiring shall be installed in raceways. (Raceways include conduits, ducts, trays, surface raceways, and wireways.) The only exceptions include:

1. NEC Type MI cable.
2. Control wiring at VAV boxes, serving sensors and actuators associated with that VAV box.

3. Type MC Cable serving light fixtures.
4. Type MC cable run in hollow wall cavities
5. Manufacture prepared wiring systems associated with lighting fixtures. An example of this would be, Lithonia 'RELOC'. Said systems shall have a corrugated metal cover.

Wiring of different voltage levels shall be segregated. Wiring of different voltage levels shall not share raceways (except wiring to rooftop receptacles, rooftop motor controls and motor disconnect early break auxiliary contacts may share raceways with motor feeders).

Six hundred (600)-volt power feeder wiring shall be spliced with solderless compression butt splices or ring lugs and terminated with solderless compression ring lugs.

Branch circuit wiring, lighting wiring, and control and instrumentation wiring shall be spliced with wire nut connectors.

Control and instrumentation wiring shall be terminated with solderless compression ring or spade lugs.

NEC Type MI cable shall be supported and protected in accordance with its manufacturer's instructions to maintain its UL fire resistive listing, and shall be spliced and terminated with special fittings from the same manufacturer as the cable.

Home runs of 20 amp branch circuits that exceed 150 feet in length shall be No. 10 AWG wire.

Home runs of 480 volt or 208 volt, 20 amp or 30 amp, single phase branch circuits that feed special receptacles shall be installed using 5 wires. Terminate the spare wires to ground at both ends.

Cables and wires terminated in panels shall be uniquely identified by permanent tags.

The shields of shielded instrumentation and control cables shall be grounded at one end only. The shields at the other end shall be insulated from ground.

Color Coding

All wiring shall be color coded, continuous color coded, or tape color coded at each termination and at each intervening 'box/point. 'If no color coding system exists, Campus circuits shall be color coded as follows:

1. Three Phase Power Over 600 Volts:
 - Phase X(A): Black
 - Phase Y(B): Red
 - Phase Z(C): Blue

2. Three Phase Power 480/277 Volts:
 - Phase X(A): Brown
 - Phase Y(B): Orange
 - Phase Z(C): Yellow
 - Neutral: Gray
 - Ground: Green
3. Three Phase Power 208/120 Volts:
 - Phase X(A): Black
 - Phase Y(B): Red
 - Phase Z(C): Blue
 - Neutral: White
 - Ground: Green
4. Single Phase Power 240/120 Volts:
 - Phase X(A): Black
 - Phase Y(B): Red
 - Neutral: White
 - Ground: Green
5. Fire Alarm Wiring (Being updated and expanded for easier identification):
 - Addressable Device: #18 Shielded Twisted Pair (STP) Red with Black Stripe
 - Horn, Horn/Strobe or ZAM Positive (+) 24 VDC: #14 Red
 - Horn, Horn/Strobe or ZAM Negative (-) 24 VDC: #14 Black
 - Speakers: #18 STP Solid Red
 - Strobe Light Positive (+): #14 Solid Yellow
 - Strobe Light Negative (-): #14 Solid Blue
 - Panel Communications: #18 STP Red with Black Stripe
 - Fireman's Telephone: #18 STP Red with Yellow Stripe
6. Synchronized Clock Wiring:
 - Line: Black
 - Neutral: White
 - Clock Correction: Red
7. Less Than 120 Volts: Use Industry Standard Methods

Site lighting wire insulation shall be in solid colors to match the circuit voltage and phase color code.

All UMHS owned facilities, unless noted otherwise, (University Hospital, THC, etc.) circuits shall be color coded as follows:

1. Three Phase Power Over 600 Volts:
 - Phase X(A): Black
 - Phase Y(B): Red
 - Phase Z(C): Blue
2. Three Phase Power 480/277 Volts:
 - Phase X(A): Red
 - Phase Y(B): Blue
 - Phase Z(C): Black
 - Neutral: Gray
 - Ground: Green
3. Three Phase Power 208/120 Volts:
 - Phase X(A): Yellow
 - Phase Y(B): Orange
 - Phase Z(C): Brown
 - Neutral: White
 - Ground: Green
4. Less Than 120 Volts: Use Industry Standard Methods



GROUNDING AND BONDING FOR ELECTRICAL

Scope

Provide grounding in accordance with the requirements of the NEC, these guidelines, and University Inspection Authorities.

The resistance of the completed ground system for standard installations shall not exceed 5 ohms. If any special equipment being installed requires a lower ground system resistance, that equipment manufacturer's maximum ground resistance shall apply.

The incoming power to the building shall always be considered the building's 'Service' (as defined by NEC Article 230), even if power is from another University facility. Size the bonding conductor in accordance with Article 230.

If equipment being installed requires a special or an isolated ground system, the equipment manufacturer's requirements shall be considered. Single point radial (star) ground systems are acceptable. Avoid providing an isolated ground system unless absolutely necessary to meet a manufacturer's warranty requirements.

When installing a new substation, either in an existing building or in an addition, connect the ground mats of the substations together. Also connect the new substation to building steel, the associated incoming duct bank (when a new duct bank entrance is installed), and to all water services.

Material Requirements

Grounding system conductors making up the grounding mat and associated ground risers, and/or for encasement in concrete shall be No. 4/0 AWG bare, stranded copper.

Ground conductors for all power distribution equipment, end-use equipment and all branch circuits, shall be insulated stranded copper conductors, color coded green or (a continuous) green color with 1 or more yellow stripes. The size shall be in accordance with NEC, except that none shall be smaller than No. 12 AWG.

Underground and concrete encased ground connections, all connections to and a-part-of the main substation grounding bar, and all ground connections to structural steel, shall be made using Cadweld exothermic weld-type connectors, or "Burndy Hyground" connectors.

Exposed ground connections to power generation and distribution equipment shall be made using copper compression ground fittings or compression lugs bolted to the equipment.

Splices and taps of ground conductors No. 8 AWG and larger shall be of the Cadweld exothermic weld type. Tape or coat all exposed splices and taps.

Design Requirements

Extend ground conductors from the ground system to all switchgear, transformers, unit substations, motor controllers, panelboards, control panel ground buses, and ground bars. Equipment rated above 480 volts, or 600 amperes shall be grounded by two independent grounding conductors.

The enclosures of all switchgear, transformers, unit substations, motor controls and panelboards shall be grounded by a separate grounding conductor to the ground system.

Motors rated 460 volts and below shall be securely bonded to the ground system either by means of a stranded copper ground conductor connected to building steel, or by a motor feeder ground conductor. Motors rated above 460 volts shall be bonded by 2 independent ground conductors.

A separate grounding conductor shall be used for all new feeders and branch circuits. Ground underground duct banks for primary or secondary power cables with a No. 4/0 AWG bare stranded copper ground wire that is run within the duct banks and is grounded at both ends.

Conduit shall not be used as the ground conductor.

Ground each manhole with 4 - 3/4 inch diameter by 10 feet long ground rods, one driven inside or outside of the manhole at each corner. Connect the ground rods with a No. 4/0 AWG bare, stranded copper ground wire loop. Pigtails from the ground wire loop shall be used to ground the manhole cover frame, ladder, concrete inserts or cable racks, duct ground wires, and the shields of any primary cables that are spliced in the manhole.

Ground the lightning protection system to separate ground rods. The main ground system shall not be used. Connect the lightning protection ground system, to the main grounding system, after the lightning protection system is completed and tested

Ground instrumentation and electronic devices in accordance with the NEC or the manufacturer's recommendations, whichever is stricter.

Conduits, cable trays and all other raceways shall be grounded/bonded in accordance with the NEC.

The shields of medium-voltage shielded power cables shall be grounded at both ends. The shields of shielded power cables spliced in a manhole shall also be grounded in the manhole.

The shields of shielded instrumentation cables shall have their drain wires grounded at one end only. The shield at the other end of the cables shall be isolated from ground.

Provide protection for ground conductors subject to physical damage or abuse. Where metallic conduit is used for physical protection of a ground conductor, the conductor shall be bonded to the conduit at both ends.

Installation Requirements

Instruct the Contractor to test the grounding in accordance with Section 16950, and to provide the University Project Coordinator with test reports



ELECTRICAL MATERIALS AND METHODS

Scope

Provide raceways for all wiring. All exposed and concealed wiring (including low voltage control, telecommunications, and power limited wiring) shall be installed in raceways.

Provide spare raceways for future use.

- From recessed lighting and receptacle panels, to the above ceiling spaces for future circuits.
- In parking structures for future CCTV cameras and entrance controls.
- In animal rooms, and at environmental rooms, for future environmental monitoring.
- Telecommunications conduits on laboratory benches for future data connections.
- Power and data conduits in wet laboratories for clusters of high-powered computers.

Related Sections

Design Guideline Sections:

[260543 - Underground Services for Electrical Systems](#)

U-M Standard Details:

[260000 Series - Electrical Standard Details](#)

Conduits

Specify 1/2 inch through 4 inch diameter electrical metallic tubing (EMT) for indoor concealed, and exposed installations, not encased in concrete.

Specify galvanized rigid steel conduit or intermediate metal conduit (IMC) for:

- Indoor installations over 4 inches in diameter.
- Indoor installations embedded in concrete.
- Indoor installations of primary power cables and fire pump supply cables. Also encase these conduits in 2 inches (minimum cover) of concrete where they are routed through the building. As an alternative, NEC Type MI cable may be used without raceways for fire pump supply cables, but only with special permission.
- Outdoor installations above ground.

Specify Schedule 40 PVC conduit for installations embedded in concrete, except as noted in Section 16110.

Specify standard wall, fiberglass reinforced epoxy, conduit for installations in parking structures, tunnels and on cooling towers.

Specify flexible metallic conduit for final connections to recessed lighting fixtures. As an alternative, manufactured wiring systems or Type MC cable may be used above accessible ceilings. Manufactured wiring systems or Type MC cable shall not be used above permanent ceilings or in walls.

Specify liquid tight flexible metallic conduit for final connections to transformers, motors and other equipment subject to vibration or removal for maintenance. Final connections to transformers in electrical rooms only may be non-liquid tight flexible metallic conduit.

Connections to recessed power receptacles, and light switches, in areas with accessible ceilings:

- A. In new 'metal stud and gypsum board partitions (walls)', the final connections may be made with type MC cable. This MC cable, shall:
 - 1. Be run to a box immediately above the accessible ceiling, and the box size shall not exceed 4-11/16" square.
 - 2. Conduit shall be used for the entire run, from this junction box, to the power source, load (lights), etc.
 - 3. No more than three circuits may be run through any given junction box.
 - 4. Individual conductors making up the MC cable shall be stranded copper, with separate grounding conductor, and steel corrugated armor. Individual conductors shall be color coded as required in section 16120.
 - 5. The MC cable is terminated using UL listed hardware intended for the cable and boxes being used, (and rated for commercial and industrial environments).
 - 6. The MC cable shall be secured in the wall cavity as required by NEC
 - 7. The MC cable shall be as short as it is necessary to serve the need and meet the Code
- B. In existing 'metal stud and gypsum board partitions (walls)', where the wall is not being otherwise opened up, the final connections to new devices may be made flexible conduit and standard (separate) conductors. This flexible conduit shall:
 - 1. Be increased in size as necessary to maintain the proper fill for the wiring to be installed.
 - 2. Shall be installed and secured as required by NEC.
 - 3. Shall be as short as it is necessary to serve the need and meet the NEC.
- C. In all other wall types and conditions use standard conduit, of the type appropriate for the wall construction.

Connections to other recessed devices, (including communication outlet boxes, junction or pull boxes, etc) shall be with standard conduit of the type appropriate for the wall construction

Specify ladder-type cable trays for:

- Telecommunications cables in telecommunication rooms, in laboratories, and corridors with open or accessible ceilings, and under computer room raised floors.
- Avoid installing cable trays in air plenum spaces.
- Overhead primary cables within substation rooms.
- Provide rollouts or vertical drops for routing the cables into the substation's primary switches.

Avoid specifying center spline cable trays, except where obstructions or support restrictions make installation of ladder cable tray impractical.

Surface Raceways

Where conduits cannot be concealed, specify metallic or plastic surface raceways for indoor exposed installations in finished areas to feed surface mounted outlets.

Boxes

Specify sheet steel switch and outlet boxes for use with EMT, and cast or malleable iron boxes for use with galvanized rigid steel conduit and IMC.

Specify PVC boxes for use with PVC and fiberglass reinforced epoxy conduit.

Specify compatible boxes, from the same manufacturer and of the same product line, for use with surface raceway installations.

Products

Conduits

Electrical metallic tubing shall be thin wall steel tubing, electro-galvanized or hot dipped galvanized inside and outside. Fittings and bushings shall be galvanized steel setscrew type connectors. Conduits 2" and larger will have fittings and bushings with two screw connectors.

Galvanized rigid steel conduit and intermediate metal conduit shall be hot dipped galvanized inside and outside, in 10' lengths and threaded on both ends. Fittings and bushings shall be threaded, cast or malleable iron, and hot dipped galvanized inside and outside.

PVC conduit and fittings shall be Schedule 40 and UL Labeled for 90 degrees C cables. Fittings shall be Schedule 40, solvent type, and from the same manufacturer as the conduit.

Fiberglass reinforced epoxy (FRE type) conduit shall be standard wall thickness, iron pipe size, sunlight resistant, and gray or black color. Fittings shall typically be push-fit on straight sections and solvent type at fittings and boxes. Connections of FRE conduit to PVC boxes shall be made with solvent type threaded fittings. Fittings shall be from the same manufacturer as the conduit.

Flexible metallic conduit shall be galvanized steel or aluminum. Fittings shall be of steel with cadmium or galvanized finish. Fittings shall be machine screw clamp type, single or two-piece. Self-locking, twist-in type fittings are not acceptable.

Liquid tight flexible metallic conduit shall consist of a flexible, galvanized steel core, a continuous copper ground strip and a polyvinyl chloride jacket. Fittings shall be steel liquid tight grounding type and from the same manufacturer as the conduit.

Cable Trays

Ladder type cable trays shall be aluminum with a 4-inch (minimum) rail height, and 9 inch maximum rung spacing. Rungs shall provide a flat surface for cable support of at least 5/8". The tray with a 10' span shall be capable of sustaining a working load of 75 pounds per lineal foot (50 pounds of cable per foot, plus a 250 pound person sitting at mid-span), with a load deflection of 1.0 inch maximum when tested in accordance with NEMA VE1-3.01. 'Fittings' shall be from the same manufacturer and product line as the tray, and shall also have a 9-inch maximum rung spacing, and a 12-inch minimum bend radius. The side rail (or equivalent) shall be continuous through the 'fittings'. Preferred, but not required, are pre-drilled mounting holes on the upper surface of the side rails - will facilitate conduit terminations at the tray

Center spline cable tray (when allowed) shall be aluminum with top mounted rungs, 3 inch (minimum) load depth, 3/4" inch minimum (flat) rung width, and 9 inch maximum rung spacing. The tray with a 10' span shall be capable of sustaining a working load of 75 pounds per lineal foot (50 pounds of cable per foot, plus a 250 pound person sitting at mid-span), with a load deflection of 1.0 inch maximum when tested in accordance with NEMA VE1-3.01. Fittings shall be from the same manufacturer and product line as the tray, and shall have a 3/4" inch minimum rung width, a 9 inch maximum rung spacing, and a 12 inch minimum bend radius.

Tray fasteners shall be galvanized or zinc plated steel; and shall be configured and installed so no sharp, or threaded surfaces, protrude in the 'cable space'.

Surface Raceways

Surface raceways shall consist of a base and cover of .040-inch thick minimum zinc plated or galvanized steel, or PVC, sized for the number of conductors contained within. Complete the installation with all connectors, fittings, bushings, boxes, covers and mounting hardware from the same manufacturer. All materials for a given location shall be of same color; with the color specified being one of the manufacturer's standard finishes.

Provide barriers to separate conductors of different voltages, or services.

Surface raceways shall be sized so that the installed wiring does not exceed NEC specified fills, and the minimum bend radius of the installed wiring is not violated - even at outlet box locations. [The telecommunication wiring will be Category 5E (4 pair), Category 6 (4 pair cable) and/or fiber strands, all to be installed without violating their minimum bend radius.]

Owner Installed Telecommunication Wiring

When calculating raceway fills, for telecommunication raceways assume 3, 4-pair, cables to each telecommunication outlet. This is the standard currently being used by the University

Boxes

Fixture, switch, outlet, splice and wire pulling boxes shall be cast or formed from carbon steel sheets of commercial grade steel not less than 14 gauge. Boxes shall be of one-piece construction, zinc or cadmium plated. Boxes shall be tapped for installing covers and plates as required.

Steel pull and junction boxes shall be rated NEMA 1 indoors, or NEMA 3R minimum outdoors, fabricated from galvanized or painted code gauge cold rolled carbon steel sheets. Boxes shall be of welded construction with flat, removable covers. Box covers shall be fastened in place by machine screws or hinges and latches. Self-tapping or sheet metal screws are not acceptable.

PVC pull and junction boxes shall be rated NEMA 3R minimum, molded in one piece, with integral mounting feet and flat, gasketed, removable covers. Box covers shall be fastened in place by machine screws. Self-tapping or sheet metal screws are not acceptable.

Supports

Hangers and brackets shall be made of steel pipe, channel iron, angle iron or prefabricated steel channel, and shall be galvanized or painted.

Hangers shall be of sufficient strength, and spaced, such that their deflection at any point does not exceed 1/240 of the hanger span length after the supported equipment, conduits, cable tray and cables are installed.

Anchors for heavy and large loads, mounted to gypsum board, hollow tile, block, or similar surfaces, shall be toggle bolt type. Install metal backer plates as needed for concentrated, or extra heavy, loads to be mounted to gypsum board walls. For heavy or large loads mounted to solid surfaces, use metal expansion, or epoxy anchors. Use lead shield anchors, or plastic expansion anchors, for supporting smaller loads. Powder-driven anchors shall not be used.

Execution

Raceways

Minimum power and control conduit size shall be 1/2 inch. Minimum telecommunications conduit size shall be 1 inch.

All medium (primary) voltage raceways, and any other raceways above 4", shall be rigid.

FRE raceways and PVC boxes shall be used in parking structures, tunnels, cooling tower enclosures, and all other areas with high humidity and/or corrosive environments. Tunnels sections passing through building mechanical rooms (and other related areas) are not exempted from these requirements even if non-FRE conduits are currently present.

Conduits in finished areas shall be concealed wherever possible and practical. When conduits cannot be concealed in finished areas, surface raceways shall be used.

Concealed and exposed raceways shall be installed parallel to or at right angles to building lines. Surface raceways shall be installed as close to room corners or trim features as possible to make the surface raceways less obvious. Use the surface raceway to route the wiring to a junction box above the finished ceiling whenever possible.

In renovation areas, with existing gypsum board walls, flexible conduit may be used from the new outlet box in the wall, to a junction box mounted on the wall immediately above the accessible ceiling. Size flex raceway to maintain equivalent cross-sectional area.

Raceways and other electrical equipment shall be separated from steam pipes, hot water pipes, and other hot surfaces by a minimum of 4 inch horizontally or 12 inch vertically.

Raceways and other electrical equipment shall be separated from ductwork and pipes so that they do not come into contact with each other.

Low voltage signal circuits shall be separated, or shielded, from power circuits to prevent the induction of noise into the signal circuits.

Raceway fittings and bends shall have bend radii greater than the minimum bend radii of the cables enclosed.

Metal raceways, fittings, boxes and enclosures shall be mechanically joined together to form a continuous electrical conductor providing effective electrical grounding continuity. This requirement, does not, however, negate the Guideline requirement for separate grounding conductors for all power circuits (as defined in Guideline Section 16450)

Raceway expansion fittings shall be provided at the intervals specified by the manufacturer, and all building expansion joints.

Directional changes in primary conduits above ground shall be made with 3' minimum radius sweeps and long radius elbows. Those underground shall be with 20' minimum radius bends.

Conduits entering panels located outdoors, in parking structures, in steam tunnels and on cooling towers shall enter from the sides, back, or bottom. Conduits shall not enter from the top.

Weep holes shall be drilled in the bottom of all switch and outlet boxes installed in parking structures and tunnels.

Mounting Heights

Equipment and devices shall be installed at the following heights:

- Receptacles (Wall): 18" A.F.F. to center
- Receptacles (Above Counter): 48" A.F.F. to center
- Receptacles (Unfinished Area): 48" A.F.F. to center
- Surface Raceway Receptacle Strips: 42" A.F.F. to bottom (unless noted otherwise)
- Light Switches: 48" A.F.F. to center
- Telephone Outlets (Wall Phone): 54" A.F.F. to center
- Telephone/Data Outlets: 18" A.F.F. to center
- Clock Outlets: 88" A.F.F. to center
- Fire Alarm Pull Stations: 48" A.F.F. to center
- Fire Alarm Horn/Strobes: 80" A.F.F. to bottom or 6" below ceiling (whichever is lower)
- Card Readers: 48" A.F.F. to card slot
- Security System Controls: 48" A.F.F. to center
- Thermostats/HVAC Controls: 48" A.F.F. to center
- Electrical Panels: 72" A.F.F. to top
- Safety Switches/Motor Starters: 72" A.F.F. to top (except top of handle shall not exceed 78" A.F.F.)
- Motor Control Switches/Pushbuttons: 60" A.F.F. to center

Supports

Electrical equipment and raceways shall be supported independently of supports provided by other trades.

Equipment (other than conduit) to be surface mounted to masonry or concrete walls shall first be secured to steel channels that in turn are mounted to the wall. Do not mount the equipment directly to masonry or concrete.

Equipment to be surface mounted on other wall surfaces may be directly mounted to the wall, unless the equipment's load exceeds the strength of the wall material. Where weight exceeds wall capability, in finished areas, install steel backer plate in the wall. In unfinished areas install steel channels as noted above to spread the load.

Floor mounted equipment shall be secured to 4 inch thick concrete housekeeping pads. Pads to be sized 4 to 6 inches longer, than equipment's length and width. Bevel edge of pads, and reinforce as appropriate.

Conduits and boxes shall be supported using steel conduit straps or 1/4-inch minimum diameter threaded rod hangers. Conduits shall be supported at intervals not exceeding 10 feet. Suspended ceiling hangers or hanger wire shall not be used (except to support manufactured wiring system cables and Type MC cables).

Cable trays shall be supported with support brackets or 3/8-inch diameter minimum threaded rod hangers at intervals not exceeding 8 feet for straight runs. Additional supports shall be provided at tray fittings.

Flexible metallic conduit to motors and similar equipment shall not exceed 3 feet in length, and shall have adequate slack to absorb the maximum vibration.

Flexible metallic conduit to lighting fixtures shall not exceed 6 feet in length. Place box and flex conduit so the light fixture can be lifted out of accessible ceilings when required, and/or long enough to place fixture in adjacent 'tile' location

Flexible metallic conduits, and manufactured wiring system cables, shall be routed parallel to or perpendicular to building lines, in a neat and workmanlike manner. Any excess cable shall be coiled and supported independently of the ceiling grid system at intervals not exceeding 3 feet. Said cables shall not lie on the ceiling tiles. These same requirements shall apply to cables placed below raised floors.

Penetrations, Sleeves and Seals

Scanning for electrical conduits shall be performed prior to core drilling concrete floors.

- Use a Hilti Ferrosan or similar impulse induction type scanner capable of detecting both metallic conduits and copper wires in PVC conduits. Tracers that scan for energized cables or that scan for injected high frequency signals are not acceptable.
- Notify the Owner's Inspection Department prior to all tests.
- Prior to core drilling, arrange for the Owner's Representative to notify building occupants of the potential for an unscheduled power outage.
- Conduits damaged during core drilling shall be restored immediately at the Contractor's expense.
- Penetrations shall be cut neatly and to the minimum size required for installation of the equipment and raceways.

Galvanized steel pipe sleeves shall be provided for conduits penetrating floors, exterior walls and roofs. As an alternative in floors, a Hilti CP680 Cast-In Firestop Device may be used.

- Extend floor sleeves above the floor a minimum of 2 inches.
- Embed sleeves in new concrete or step-core concrete and grout sleeves into existing concrete with epoxy grout.
- Seal floor sleeves using fire-sealing systems approved by a Nationally Recognized Testing Laboratory.
- Seal exterior wall and roof penetrations water tight.

Conduit penetrations in walls shall be patched on both sides to seal against the passage of air, sound, smoke, and fire.

- Seal conduit penetrations in fire rated walls using fire-sealing systems approved by a Nationally Recognized Testing Laboratory.
- Seal conduit penetrations in non-rated walls using masonry materials that match the wall construction.

Cable tray penetrations in fire rated walls shall be sealed using fire sealant bag or brick systems approved by a Nationally Recognized Testing Laboratory.

Recessed outlet boxes, located less than 24 inches apart, on opposite sides of a fire rated wall, with box openings over 16 square inches, shall both be fire sealed.

Identification

Systems and equipment shall be provided with nameplates indicating their name or number, and power source. Nameplates shall be engraved 1/8-inch thick plastic with black letters on a white background, and letters at least 1/4 inch high. Nameplates shall be attached with a minimum of two mechanical fasteners such as sheet metal screws or bolts and nuts. Embossed plastic tape labels are not acceptable.

Receptacle and switch plates shall be labeled to indicated panel and circuit serving the device. Also mark the same circuit information, inside the outlet box, using indelible ink. "Black on clear Dymo", tape markers, are acceptable for this requirement

Junction boxes and box covers of special circuits shall be color coded as follows:

- Emergency power and Fire Alarm Circuits: Red Paint
- Temperature Control Circuits: Blue Paint
- Clock Circuits: Orange Paint

Junction box covers shall be marked in indelible ink, with the panel name, and breaker numbers of the circuits contained within.

Conduits and cables in the University tunnel system shall be banded at major changes in direction, junctions, entrances to buildings and every 25 ft on straight runs. Banding shall be tape similar to Scotch #33 electrical tape, which is suitable for high temperatures.

- Electrical Power: Red
- Clock System: Red with Purple
- Radio System: Red with Silver
- Computer System: Red with Yellow
- High Voltage: Red



UNDERGROUND SERVICES FOR ELECTRICAL SYSTEMS

Scope

Provide concrete encased duct banks for primary (medium voltage) power distribution cables, and telecommunications cables.

Provide direct buried ducts for secondary power cables, site lighting cables, and dedicated telecommunications circuits.

Always provide spare ducts in concrete encased duct banks. When installing direct buried ducts under sidewalks, walkways and other paved areas, install a least one additional; 6" PVC sleeve for installation of future ducts without the need to re-open the paved area.

Related Sections

Design Guideline Sections:

033053 - Miscellaneous Cast-in-Place Concrete

[265600 - Exterior Lighting](#)

U-M Standard Details:

[260000 Series - Electrical Standard Details](#)

Underground Ducts

Specify Type DB PVC conduit for concrete encased duct banks, except where galvanized rigid steel conduit is required for additional strength.

Specify Schedule 40 PVC conduit for direct buried ducts, except where galvanized rigid steel conduit is required for strength or due to inadequate cover.

Under roadways, driveways, parking lots and sidewalks, and all other paved areas, specify Schedule 40 PVC conduit sleeves to enclose direct buried ducts.

Manholes and Pull Boxes

Specify reinforced concrete manholes where required to:

1. Satisfy cable routing needs, to control pulling tensions, and for cable splicing.
2. Keep duct lengths to 400 feet or less on straight runs. Longer runs are acceptable only when calculations are completed showing that pulling tensions, and sidewall pressures are not exceeded in the longer pull.
3. Keep the maximum amount of bends between manholes to no more than 180 degrees.

- a. When bends are present the maximum length of the duct must be appropriately reduced so the limiting (maximum) pulling tension, and maximum sidewall pressures of the cables are not exceeded.
- b. Designer shall do sufficient calculations to insure that the two, above noted, limiting factors are not violated.
- c. The typical medium voltage feeder being installed is composed of 3-1/C, 350 MCM copper, 15kV (ungrounded) cables, with tape shields, and EPR insulation rated for 133% of the 15kV nominal rating.

Specify pre-cast polymer pull boxes, only in owner-approved locations, where adequate space does not exist for the installation of manholes.

Manholes and pull boxes shall be accessible on at least 3 sides by trucks, cable reel trailers and other cable pulling equipment.

Products

Underground Ducts

PVC conduit for concrete encasement shall be Type DB, 4-inch diameter minimum, UL Labeled for 90 degrees C cables. Fittings shall be Type DB, solvent type, and from the same manufacturer as the conduit.

PVC conduit for direct burial shall be Schedule 40, UL Labeled for 90 degrees C cables. Fittings shall be Schedule 40, solvent type, and from the same manufacturer as the conduit.

Galvanized rigid steel conduit shall be hot dipped galvanized inside and outside, in 10 foot lengths and threaded on both ends. Fittings and bushings shall be threaded, cast or malleable iron, and hot dipped galvanized inside and outside.

Sleeves shall be Schedule 40 PVC conduit, 6-inch diameter, UL Labeled for 90 degrees C cables. Couplings shall be Schedule 40, solvent type, and from the same manufacturer as the conduit.

Concrete shall have a minimum strength of 3,000 psi at 28 days.

Marker tape shall be plastic, vinyl, or Mylar, 6 inches wide, red for electrical power and orange for telecommunications, and labeled to indicate the type of circuit buried below.

Manholes

Manholes shall be precast, or cast in place, and shall be steel reinforced as needed, to achieve an MDOT highway loading of H-20.

Provide a cast iron frame with cover, a galvanized steel ladder, and galvanized pulling eyes embedded in the concrete opposite each duct entrance and in the floor beneath the cover.

Provide a sealed depression in the floor offset slightly from the center, for installation of a portable sump pump. Drains shall not be installed in floors.

Manholes placed in 'green-belts' and like areas shall have manhole covers with a lighter duty rating (the manholes themselves and the 'ring', however, are the same as required for the MDOT, H-20 rating)

All duct entries into manholes shall include provisions for bell end fittings and a means to securely 'securing' the duct bank(s) to the manhole wall

1. Precast, or cast-in-place, manholes shall be delivered (or constructed) with the ducts openings cast in place.
2. Provisions for known future ducts shall have knockouts installed, with the bell end fittings included.
3. When installing multiple new ducts into manholes without proper knockouts, cut an opening in the manhole wall, rework steel reinforcing, and install ducts, all in accordance with the associated U of M standard detail.
4. Alternately, when installing multiple new ducts into manholes without proper knockouts, the duct openings may be core drilled at the proper locations. The diameter of the corings, however, shall be 2 to 4" larger than the duct being installed. This larger opening will allow proper grouting of the ducts and bell ends into the manhole wall.

Electrical Power Manholes

Electric power manholes shall have inside dimensions of 10 feet long by 10 feet wide by 7 feet high. Duct entry points shall be offset from the center of the wall to allow easier training of the cables along the walls of the manhole. Provide a grounding system for each manhole and connect this to grounds run with power duct banks. Make all grounding system connections using exothermic welds, or copper (or bronze) fittings as manufactured by Burndy Hyground System.

The frame and 36" cover for electrical power manholes shall be East Jordan Iron Works 1580C in high loading areas, or 1581-51 in green belt areas. Both have the lettering, "UM ELEC".

Electric power manholes shall be equipped with 3 Aickenstrut (non-metallic) stanchions per wall, each bolted to the wall with stainless steel Rawl bolts. Each stanchion shall be fitted with 1 Aickenstrut (non-metallic) cable support arm.

Telecommunication Manholes

Telecommunications manholes shall have inside dimensions of 12 feet long by 6 feet wide by 6.5 feet high. Duct entry points shall be offset from the center of the wall to allow easier training of the cables along the walls of the manhole. Ducts shall only enter on the shorter end walls, not on the long walls. The frame and 27" cover for telecommunications manholes shall be East Jordan Iron Works 1805C with the lettering, "UM TELECOM".

Telecommunications manholes shall contain 7 full height vertical concrete inserts in each long wall, and 2 in each short wall. Inserts shall be 1-5/8 inch hot dipped galvanized Unistrut type channel or Aickenstrut nonmetallic channel of equal size and strength. Corner inserts shall be equipped with 12 inch corner brackets and side inserts shall be equipped with 3 inch side brackets to support full height perforated cable support racks. Each long wall shall also be equipped with 2 copper ground bus bars, 6 inches long by 2 inches wide by 1/4 inch thick, on 2 inch metal stand-offs bolted to the concrete.

Pull boxes

Pull boxes shall be precast polymer concrete or polymer foam, heavy duty rated, bottomless, with a single piece cover. Pull boxes shall be one size larger than required to loop cables out of the opening and back in again without exceeding the minimum bend radii of the cables. Covers shall be of sufficient strength to withstand the weight of a riding lawn tractor or small truck, engraved "UM ELECTRIC", "UM TELEPHONE", or "UM OUTSIDE LIGHTING" as applicable, and attached with pentahead stainless steel bolts.

Grounds

Ground splices and connections at manholes and pull boxes, where required, shall be exothermic welds, or copper (or bronze) compression ground fittings, or bolted compression ground fittings.

Execution

Excavation and Backfill

Miss Dig shall be contacted at (800) 482-7171 before performing any excavation work.

Provide barricades around open holes and trenches, temporary bridges over trenches cut through major sidewalk routes. Major sidewalk routes shall not be closed to pedestrian traffic.

Trees, shrubs and plantings in the area of excavation shall be removed by the Plant Grounds Department in advance. Provide barriers to protect landscaping adjacent to the excavation area.

Remove rocks, concrete, or other debris encountered during excavation.

Where sidewalk sections must be removed for installation of underground ducts, remove the sidewalk sections (flags) completely from joint to joint.

Cut asphalt to be removed for installation of underground ducts, in two, straight, parallel lines.

Backfill excavations in 6 inch layers and mechanically compact to 98 percent compaction. Excavated materials may be used as backfill only if the backfill is sand or clean dirt that is free of rocks and debris over 3/4 inches in diameter. Dispose of clay, rocks, concrete and other debris, and replace with MDOT Class II sand.

In landscaped areas, backfill and mechanically compact to a depth of 6 inches below grade. Backfill the last 6 inches with clean topsoil, and reseed affected lawn areas.

Restore concrete sidewalks and asphalt in accordance with University Guidelines.

Underground Ducts

Slope duct banks downward, toward manholes, and away from buildings, a minimum of 6 inches per 100 feet. Duct banks shall not route water from manholes into buildings, or contain traps between manholes where water may accumulate.

Directional changes in duct banks shall be made with 20' minimum radius bends. Where this radius cannot be accommodated, perform detailed pulling tension, and sidewall pressure, calculations, to insure compliance with cable manufacturer's recommendations.

Duct banks and direct buried ducts shall be supported on undisturbed soil or on piers extending down to undisturbed soil.

Where primary voltage power, and telecommunications, duct banks run in parallel, they shall be separated by a minimum of 12 inches of soil or concrete - vertically and/or horizontally. If the services need to be placed one upon the other the (vertically stacked), the power ducts shall be above the telecommunications ducts

Primary duct banks shall include No. 4 steel reinforcing bars. Telecommunications duct banks do not require steel reinforcing.

Ground primary duct banks with a No. 4/0 AWG bare stranded copper ground wire that is run within the duct bank and is grounded at both ends. . Direct buried ducts shall be grounded by insulated, stranded copper ground wires installed in each duct. Telecommunications duct banks do not require grounding

Prior to concrete encasement, ducts, reinforcing steel and ground wires shall be secured with nonmetallic straps or cable ties to nonmetallic duct spacers at intervals not exceeding 8 feet. Duct spacers shall be sized for the ducts being held, and shall provide the minimum spacing between ducts required for concrete flow and by the NEC. Duct spacers shall be anchored to the ground using nonmetallic bands and stakes.

Duct banks shall have a minimum of 3 inches of concrete cover on all sides.

Provide bell end fittings on ducts where the ducts enter manholes or buildings. Note that the use of a coupling on the end of a length of PVC pipe, is not the equivalent of a bell end fitting - only true 'bell end fitting' shall be used to meet this requirement. The duct(s) and associated bell end fittings shall be securely grouted into the wall of the manhole and/or building.

Where duct banks enter manholes or buildings, they shall be constructed as an integral part of the wall. (Do not core-drill the wall and then install end bell fittings to the edge of core-drilled hole without prior written approval from the Utilities and Plant Engineering Department.) Duct bank shall extend to the inside surfaces of the walls, and the duct bank reinforcing shall be integrated with the wall reinforcing.

Direct buried ducts and fittings shall have bend radii greater than the minimum bend radii of the cables enclosed, and shall not be smaller than the radii of standard manufactured elbows.

Route direct buried ducts at right angles to building lines and site features, and as close to curbs and sidewalks as possible to avoid interferences with future landscaping.

Where direct buried PVC ducts cannot be buried deep enough to meet the NEC minimum cover requirements, rigid steel conduits shall be installed instead, or a concrete cover shall be poured over the ducts.

Place marker tape approximately 12 inches above duct banks or direct buried ducts for the entire length of the duct run.

Contractor shall cleanout the duct, using a flexible mandrel and a stiff bristled brush, prior to cable pulling. Leave a pulling string in the duct when cleanout is complete. This will serve as the duct identification on both ends of the run

Manholes and Pull Boxes

Manholes shall be installed on a base of pea gravel or MDOT Class II sand at least 12 inches deep. Pull boxes shall be installed on a base of pea gravel or MDOT Class II sand at least 6 inches deep.

Pull boxes shall be located in mulched areas wherever possible and shall be level with the existing grade.

Provide metal barriers in pull boxes containing circuits of two different voltages, or containing both power and telecommunications circuits.

Ducts shall enter telecommunications manholes on the short sides only. Ducts may enter primary manholes on any side, but should be positioned to permit installation of additional ducts in the future. Ducts should enter as perpendicular to the wall surface as possible.

Ground electric power manholes with four, $\frac{3}{4}$ inch diameter by 10 foot long, ground rods, one driven inside of the manhole at each corner. Connect the ground rods and any duct bank ground conductors together with a No. 4/0 AWG bare, stranded copper ground wire loop. A No. 2 AWG bare stranded copper pigtail from the ground wire loop shall be used to ground the manhole cover frame, ladder support bracket, any metallic concrete inserts and metallic cable racks, and the shields of any cables that are spliced are to be grounded in the manhole.

Sleeves

Sleeves shall be buried at a minimum depth of 24" to their top. Sleeves shall extend a minimum of 12" beyond the paved areas they pass under.

Spare sleeves shall be taped closed at both ends with duct tape.

Ends of spare sleeves shall be marked with steel stakes, pipes or conduits that are 3' long minimum, driven vertically down at the sleeve ends to a depth of 6" below grade to their top.

A marker tape shall be buried in the backfill approximately 12 inches above the sleeves for the entire length of the sleeves.

Quality Assurance

The Owner's Code Inspection Department shall be contacted at (734) 764-2457 before pouring concrete and before backfilling excavations.



ELECTRICAL ACCEPTANCE TESTS

Scope

This guideline defines the standard tests that all electrical systems and equipment must pass prior to final acceptance by the University. These tests are in addition to acceptance tests specified by equipment manufacturers or defined in the other Design Guidelines sections. Obtain permission through the Design Manager before specifying tests less than or in excess of these tests.

Related Sections

[Design Guidelines Technical Sections: All](#)
[Electrical Trades Preferred Manufacturers List](#)
[U-M Master Specifications: All](#)

References

ANSI/NETA ATS, "Standard for Acceptance Testing Specifications"
NFPA 70, "National Electrical Code"
NFPA 72, "National Fire Alarm Code"

General

Acceptance tests shall be performed in accordance with the current version of ANSI/NETA ATS and by an independent testing agency. Specify only the independent testing agencies listed in the latest Electrical Trades Preferred Manufacturers List.

Tests shall be performed in accordance with applicable codes, standards, and equipment manufacturers' instructions.

The Contractor shall provide all test equipment, materials and labor necessary to perform the tests, and shall coordinate with the other trades for necessary services, such as scaffolding and the uncoupling of motors.

Tests shall consist of visual inspections, manual operations, and electrical testing under all normal and expected abnormal operating conditions.

The Owner shall be notified at least 3 working days in advance of all tests.

Tests shall be witnessed by the Owner unless such witnessing is waived in writing.

The Owner shall be provided with a written test report, signed and dated, for all tests.

Testing Criteria

High potential tests shall be performed at the AC or DC voltage listed in ASNI/NETA ATS unless specified otherwise herein. Do not perform more than one high potential test on any item without authorization from the Owner.

Dielectric absorption tests shall be performed with a 2,500 volt DC megger.

Megger tests shall be performed at a DC voltage of 1,000 volts for 600 volt rated equipment, and at a DC voltage of 500 volts for 120-300 volt rated equipment.

Continuity checks shall be performed with a low voltage DC meter, light or bell.

The resistance to ground shall be measured using either the three point method or the fall-of-potential method.

Test instruments shall be calibrated to national standards to insure the accuracy of tests. These calibration reports shall be made available to the Owner when requested. Depending upon frequency of use, the instruments shall be calibrated at least every 12 months.

Visual Inspections

Prior to manual operation and electrical testing, verify the following:

- The equipment complies with the contract documents and the shop drawing submittals.
- The equipment is completely and properly installed according to the contract documents and the manufacturer's instructions.
- Adequate working space exists around the equipment to fully open doors and access panels, and to access all components that require maintenance.
- The equipment is free from damage and defects.
- Shipping blocks and restraints have been removed.
- The equipment has been aligned.
- The equipment has been lubricated.
- The ventilation louvers are open and unobstructed.
- Electrical connections have been tightened.
- Voltages, phases, and rotation have been identified.
- Terminations have been identified.
- Equipment labels have been installed.
- The equipment has been calibrated.
- The equipment is ready to be electrically tested.

Manual Operations

Prior to electrical testing, verify the following:

- Mechanical components operate smoothly and freely.

- Mechanical stops, limit switches, etc., are properly adjusted.

Electrical Acceptance Tests

Duct Banks

A stiff bristled brush shall be pulled through each duct to clean out dirt and debris.

A solid mandrel rated for the inside diameter of the ducts and at least 5 inches long shall be pulled through each duct to verify the absence of kinks, flat spots, and other obstructions. The Owner may require the use of the Owner's mandrel.

Medium Voltage Primary Cables

A continuity test, a 2,500 volt DC megger test, a DC high potential test, and a second 2,500 volt DC megger test shall be performed on 15 kV primary cables after the cables have been spliced or terminated. The high potential test shall be performed at 45kV on new cable installations and at 30kV on existing installations or when new cable has been spliced to existing cable.

600 Volt Power Cables

A continuity check and a 1,000 volt DC megger test shall be performed on 600 volt power cables No. 4 AWG and larger. The megger test shall be performed between each pair of conductors and from each conductor to ground. Each test shall be performed for 15 seconds or until the insulation resistance value stabilizes.

The insulation resistance between conductors, and from each conductor to ground, shall be 100 megohms minimum in one minute or less. In addition, the lowest insulation resistance value shall not differ from the highest value by more than 20 percent. If all megger readings for a given circuit are above 1000-megohms, the 20 percent balance requirement may be waived.

Control Cables

A continuity check shall be performed on control and instrumentation wiring.

Substation Primary Switches

A continuity check, a 2,500 volt DC megger test, and a 37 kV DC high potential test shall be performed on primary switches.

Substation Transformers

A DC megger test and a turns ratio test shall be performed on unit substation transformers. The DC megger test shall be performed at 2,500 volts on coils rated over 600 volts, and at 1,000 volts on coils rated 600 volts and below. A turns ratio test shall be performed on each tap.

Verify proper setting and operation of the fan control panel to insure it and the fans are operable and functional. Temperature test the probes in each winding.

Substation Secondary Switchgear

A continuity check and a 1,000 volt DC megger test shall be performed on the buses and on the main, tie, and feeder breakers.

A ducfer (contact resistance) test shall be performed on main, tie, and feeder breakers in unit-substations. Maximum readings shall not exceed manufacturer limits.

The overcurrent devices of substation breakers with electronic trip units shall be tested using the primary current injection method. Secondary current injection shall not be used.

Molded case circuit breakers with thermal/magnet trips shall not be primary current injection tested.

A 1,000 volt DC megger test and a turns ratio test shall be performed on CT's and PT's.

The metering shall be calibrated.

Engine-Generators and Automatic Transfer Switches

A continuity check and 1,000 volt DC megger test shall be performed on the generator windings, generator circuit breaker, power circuit portions of the automatic transfer switches, and the interconnecting power circuit wiring.

A continuity check shall be performed on the control wiring.

The metering and time delay relays shall be calibrated and tested.

The manufacturer's recommended normal start-up testing shall be performed.

A load bank test shall be performed on the generator with a load bank rated at 100 percent of full generator output for a period of at least 120 minutes.

If the engine is natural gas fueled and Compliant Capable rather than Certified as defined in EPA 2009 NSPS emissions standards, an EPA Initial Performance Test shall be performed. This test shall consist of three separate 1 hour runs at close to full load. It shall be performed in accordance with EPA test requirements, and the measured emissions shall be within EPA limits.

Normal power shall be shut off to each automatic transfer switch, one at a time. Each time the engine-generator shall start and the automatic transfer switches shall function according to the design intent.

Normal power shall be returned to the automatic transfer switches. The automatic transfer switches shall return to normal power and the engine-generator shall shut down according to the design intent.

Normal power shall be shut off to the entire building. The engine-generator shall start and the automatic transfer switches shall function according to the design intent. Normal power shall be returned. The automatic transfer switches shall return to normal power and the engine-generator shall shut down according to the design intent.

The generator shall be tested for voltage and frequency stability. The automatic transfer switches shall be used to apply load to the generator according to the worst case step loading sequence defined in the generator specification. The generator voltage and frequency shall remain within the values listed in the generator specification.

The ATS maintenance bypass switches shall be inspected for proper labeling and tested for proper operation in all modes.

The generator and automatic transfer switch controls, gauges, status indicators, and alarms, including remote annunciators and devices in the Fire Command Center, shall be tested for proper operation.

Alarm outputs to the fire alarm and BAS systems shall be verified.

Transformers, Reactors, Switchboards, Panelboards, and Motor Control Equipment

A continuity check and a 1,000 volt DC megger test shall be performed on distribution and isolation transformers, and on line reactors.

A 1,000 volt DC megger test shall be performed on buses, motor starters, circuit breakers, and disconnect switches. This test may be combined with the power cable megger test by testing the devices and terminated cables together.

A continuity check shall be performed on motor control circuits and control panel internal wiring.

An operational test shall be performed on the motor controls.

Motor heater sizes shall be checked for proper size.

Motors

A 1,000 volt megger test shall be performed on 460 volt motors. A 500 volt megger test shall be performed on 200 volt and 120 volt motors.

Motors shall be “bumped” to verify proper direction of rotation.

Motors shall be run to verify proper ampere draw and to verify vibration and heating are within required limits.

The Electrical Contractor shall assist the Temperature Control Contractor and the Mechanical Contractor and insure proper operation of safeties, interlocks and motor controls.

Capacitors

Capacitors shall be inspected for proper fuses before testing. A 1,000 volt DC megger test shall be performed on 460 volt capacitors, and a 500 volt megger test shall be performed on 200/240 volt capacitors. After each megger test, proper discharge shall be checked.

Grounding

The resistance to ground of each ground rod in a ground mat shall be measured before connection to the other ground rods. The resistance shall not exceed 10 ohms. If the reading exceeds 10 ohms, add one extension and drive it another 10 feet. Further testing of that rod is not needed.

The resistance to ground of the total ground system shall be measured with all connections completed. The resistance shall not exceed 2 ohms for switching stations or utility (DTE) feed point services; and shall not exceed 5 ohms for building service substations.

Ground rods for manholes and light poles need not be tested.

A continuity check shall be performed from equipment ground bus bars and ground lugs to the ground system.

Lighting Fixtures

Lighting fixtures shall be checked for proper assembly, proper louvers or lenses, proper lamps, proper ballasts, straight row alignment, proper aiming, and the absence of light leaks.

Battery-backed emergency lighting fixtures shall be checked for continuous operation for a minimum of 90 minutes.

Lighting Circuits

Lighting circuits shall be checked for proper switching, for proper circuiting according to the design documents, and for circuiting that matches the lighting panel schedules.

Lighting Controls and Dimming Systems

Lighting controls and dimming systems shall be tested to verify that they have the specified features and programmability, and that all controls are properly labeled.

Lighting controls and dimming systems shall be tested to verify that the control sequences noted in the contract documents and manufacturer's instructions are present and operable, that control and dimming are smooth and free of flicker, and that fading is properly timed.

Lighting controls and dimming systems shall be tested to verify that the emergency lights function upon a loss of normal power.

Fire Alarm Systems

Fire alarm systems shall be tested in accordance with NFPA 72.

Controls that interface with the fire alarm system shall be tested in cooperation with the Temperature Controls Contractor to insure proper operation of interfaced mechanical devices.

Alarm, supervisory, and trouble outputs to the MOSCAD and BAS systems shall be tested to insure that the signals are received by Public Safety or at Plant Operations.

Special Systems

Security systems, card access control systems, sound reinforcement systems, and other special systems shall be tested in accordance with test plans submitted by their manufacturers and approved by the Owner. These test plans shall verify compliance with specifications and proper operation including all inputs, outputs, alarms, and accessories under all modes of operation.

Heat Tracing Cables and Mats

A continuity check, a 500 volt DC megger test, and an operational test shall be performed on heat tracing circuits prior to insulation of the pipe or tank. Verify proper current draw and heating of the heat tracing.

The 500 volt DC megger test shall be repeated after the insulation is completely installed.

An operational test shall be performed on the controls and alarms.



Lighting Dimming Controls

A. Dimmer and other Light Control Systems

1. The systems shall be placed, labeled, and configured to be 'user friendly and intuitive.
2. Dimming systems shall not be 'shared' among multiple rooms, unless those rooms are separated by a movable partition.
3. When the room size is above 400 square feet, the dimming system shall have its own 'software' to schedule the lighting, or otherwise save lighting energy when the space is un-occupied. Alternately, it may be connected into the building lighting control system when one is available
4. Whenever possible, install new systems to be similar in operation and function to other systems already in the building for easier understanding and operation on 'users'.
5. In rooms with an installed A/V system, the dimming controls shall be coordinated with and integrated into the user control panel (screen) of that A/V system so all controls can be centralized for the instructor (user of the space).

B. Lighting control systems

1. Lighting control systems installed to only save energy (scheduling, and/or otherwise saving lighting energy), may serve multiple rooms.
2. All rooms larger than 400 square feet shall be connected to the lighting control system of the building, and/or have its individual controls.
3. Lighting control systems shall be integrated into the overall building control system, and the installed dimming systems
4. In rooms with more than one door, provide a full set of controls at the most frequently used door. At the remaining doors provide controls for at least portion of the lights.
5. When an energy analysis determines that room ventilation can be reduced when the room is unoccupied or fume hood flow can be reduced when nobody is standing at the hood, connect one dry contact of the occupancy sensor to the lighting system and provide a second dry contact for use by the building DDC system.

C. Owner Training

Specify that the installing contractor train the occupants of the space on how to operate the system, and that University Maintenance and Operations be instructed in the proper setting, adjusting, and maintaining the equipment



MEDIUM VOLTAGE ELECTRICAL DISTRIBUTION

Scope

The Central Campus, and the Athletic Campus', primary distribution systems consist of a 13.2 kV looped system, and a 2.4 kV radial system. The 2.4 kV system is slowly being upgraded to 13.2 kV.

The North Campus primary distribution systems consist of a 4.8 kV looped system and a 13.2 kV looped system. The 4.8 kV systems will eventually be upgraded to a 13.2 kV system. All primary equipment shall be designed to accommodate the upgrade in voltage.

The Hospital's primary distribution system, in general, consists of a 13.8-kV looped system. The other Hospital buildings are fed from the Central Campus's primary distribution system, as noted above. (A 13.8- to 13.2 kV conversion is being investigated.)

In general, phase rotation shall be A-B-C.

The phasing of new installations shall be A-B-C (X-Y-Z) from top to bottom, front to back, and left to right when viewed from the front. The phasing of renovations to existing installations shall match the phasing of the existing distribution. The Contractor shall be instructed to contact the University Project Coordinator to obtain High Voltage Electric Shop assistance to determine the existing phasing. The Contractor shall correct at his own expense any problems associated with his failure to match the existing phasing.

The A/E shall perform calculations needed to insure that cable manufacturer recommendations, on pulling tensions and sidewall pressures, are not exceeded when the cables are pulled into the raceway system.

Additional information on the primary distribution system and on the primary system fault capability is available from the University Utilities and Plant Engineering Department through the University Project Coordinator.

Equipment Requirements

Primary cable shall be single conductor, stranded copper, with ethylene propylene rubber (EPR) insulation rated for 15 kV with a 133% insulation level. The cable shall be rated for 90 degrees C, have a 5 mil minimum thick tape shield with a minimum of 12 ½ percent overlap, and a Polyvinyl chloride jacket.

High voltage cable terminations shall be made with Raychem HVT heat shrink termination kits or 3M Company Quick Term cold shrink termination kits only. Provide adequate workspace in high voltage equipment for installation of the termination kits.

Lugs for terminations shall be of the two-hole, solderless, compression type.

High voltage cable splices shall be made with Raychem HVS heat shrink splice kits only.

Installation Requirements

Instruct the Contractor to identify the cable phases at all high voltage terminations. Phases shall be identified by 1-1/2 inch minimum high letters painted on the cable supports or potheads wherever possible. When painting is not possible, phases shall be identified by 1/2-inch minimum high letters on lead tags permanently attached to the cables.

Normally primary voltage cables shall not be pulled into raceways exceeding 500 feet. A/E and/or contractor shall provide calculations showing that the required cable pulls do not exceed the manufacturers' recommendations for pulling tensions, sidewall pressures, cable-bending radius, and (when absolutely necessary) pulls of greater than 500-feet.

The cables shall be supported appropriately by cable tray, conduit, or approved racking methods.

Cable tray shall be aluminum ladder type. All fittings and hardware shall be from the same manufacturer as the cable tray.

Conduit shall be galvanized rigid steel or intermediate metal conduit with cast or malleable iron threaded fittings and bushings. Except in substation rooms, and/or fire pump rooms, wherever the primary voltage conduits are run through a building, the conduits shall be encased with at least 2 inches of concrete.

Instruct the Contractor to perform testing in accordance with Section 16950, and to provide the University Project Coordinator with test reports.



ELECTRICAL POWER SYSTEMS

Scope

The various Codes applicable to the University's electrical power system are mainly based upon a model of a single utility service, connected to a single premise. The University's electrical system, however, consists of multiple utility services, a cogeneration facility, and a comprehensive primary distribution network connected to hundreds of premises. Thus applying the codes to the University's electrical system is not straightforward as it would be in other locations.

To meet the level of safety intended by the Codes, the design the University's electrical distribution systems is as described herein.

Electrical System Description

Utility Services

The Detroit Edison Company DTE provides the following primary and secondary services to the University:

1. Three 13.2 kV primary services, from DTE's University Substation, to the Central Power Plant (CPP) on Central Campus.
2. Two 13.8 kV primary services, from DTE's Academy Substation, to the University of Michigan Hospitals (UMH) main distribution substation in University Hospital. (A possible conversion to 13.2 kV is being investigated.)
3. Two 13.2 kV and two 4.8 kV primary services, from DTE's Campus Substation, to the North Campus Switching Station.
4. Eleven 13.2 kV and 4.8 kV primary services to individual buildings having service patterns where the primary demand rate is cost effective.
5. Over 250 secondary services of various voltages to individual buildings.

Cogeneration Facility

The University produces steam, and generates electricity, at the Central Power Plant, a cogeneration facility that contains the following:

1. Three steam turbine-driven 13.2 kV generators with a total capacity of 37.5 megawatts.
2. Two gas turbine-driven 13.2 kV generators with a total capacity of 7 megawatts.

Primary Distribution Network

The University distributes power to most of the buildings connected to its medium voltage distribution system through the following types of circuits and service points:

1. 13.2 kV and 2.4 kV primary feeders from the Central Power Plant to most buildings on the Central Campus and Athletic Campus.
2. 13.8 kV primary feeders from the University Hospital's Substation to most of the UMH buildings on the Medical Campus. (A possible conversion to 13.2 kV is being investigated.)
3. One 13.2kV emergency feeder from the Central Power Plant, through a 13.2-13.8-kV autotransformer, to select UMH loads. (May be eliminated if 13.8 to 13.2 conversion is warranted.)
4. 13.2 kV and 4.8 kV primary feeders from the North Campus Switching Station to most North Campus buildings.

Application of the Codes

General

1. New electrical systems shall comply with the NEC and other noted codes on the U of M web page.
2. Existing electrical systems under addition or renovation shall be upgraded to comply with the current codes.
3. Existing electrical systems serving an area, undergoing non-electrical renovation, in general, are not required to be upgraded to comply with the current codes. However:
 - a. No work of any discipline shall degrade the existing electrical distribution system in any way.
 - b. Upgrade the electrical distribution systems wherever possible and practical.
4. The University's electrical system is considered "reliable" as defined in NFPA 20 Appendix A.
5. As described in NEC Section 695-3(2), the Central Power Plant could be considered an "on-site power production facility" The University, however, prefers an on-site, natural-gas-fired generator to supply the emergency power loads in a facility.

Application of NFPA 70, the National Electrical Code

1. The service points at which the Detroit Edison utility services end and the University premises wiring begin, are defined as the connections of the secondary buses or terminals at the Detroit Edison owned step-down transformers, fused cut-out switches, or service drop conductors, to the University owned cables.

2. The "source ends" (Central Power Plant or switching station ends) of the University's primary distribution cables are feeders and shall comply with NEC Article 220, "Feeders".
3. The "load ends" (building ends) of the University primary distribution cables, however, shall be treated as the utility services to the building. Install service disconnecting means and comply with all of the requirements of NEC Article 230, "Services".
4. In a like manner, a secondary-voltage feeder (or feeders) from one building to another building shall be treated as the utility's service to the building. Install service disconnecting means and comply with all of the requirements of NEC Article 230, "Services".
5. This service entrance shall fully comply with NEC Article 230, and all other applicable sections. These requirements include, but are not limited to the following:
 - a. Conductors shall be maintained outside of the building or shall be enclosed in two inches of concrete until they enter the room containing the building service disconnecting means.
 - b. Primary disconnect switches, unit substation transformers and pad-mount transformers shall be treated as utility owned equipment.
 - Access shall be restricted to qualified personnel only.
 - The transformer primary switches shall not be used as the building service disconnecting means.
 - c. The line side terminals of the secondary main disconnecting device(s) shall be treated as the building service point.

Application of the National Electrical Safety Code

In addition to complying with the NEC, the Central Power Plant, switching stations, substation rooms, manholes and other areas containing primary equipment, main service switchgear, or cables shall comply with the National Electrical Safety Code.

Application of the International Building Code

1. In low-rise buildings, provide emergency power for egress lighting, emergency signs, and the fire alarm system.
 - a. Provide a natural gas fueled engine-generator set whenever possible because the savings in maintenance costs will offset the higher initial cost. Connect the generator using one or more automatic transfer switches. These transfer switches shall be 'close-transition', soft-start, with full, isolated maintenance bypass systems included
 - b. As an alternative to an engine-generator set, consider providing a fuel cell system.
 - c. Provide a central battery/inverter system with the battery system being of the flooded-wet-cell, Plante-lead-alimony, type. Provide sufficient 'installation and working' clearances around the overall system, and installed needed ventilation. (Sealed valve

regulated battery systems shall be used due to their high maintenance replacement costs.)

- d. When an engine-generator set cannot be provided, provide individual battery packs.
 - e. Because the normal power source is sufficiently reliable, do not connect low-rise building fire pumps, elevators, or similar equipment to the engine-generator set.
2. In high rise buildings; provide emergency power for egress lighting, emergency signs, and the fire alarm system. Provide standby power for fire pumps, elevator(s), smoke exhaust systems, stairwell pressurization systems, and other standby systems as required by codes.
- a. Provide a single natural gas fueled engine-generator set with one or multiple automatic transfer switches. These transfer switches shall be 'close-transition', soft-start, with full, isolated maintenance bypass systems included
 - Provide the fire pump automatic transfer switch as an integral part of the fire pump controller.
 - Provide the elevator system automatic transfer switches as part of the building's power distribution system, not integral to the elevator controllers.
 - b. Consider supplying more than one building from a single engine-generator set.
 - c. Consider installing the engine-generator set in an adjacent parking structure or lot to minimize noise and vibration.
3. Only as a temporary measure when an engine-generator set cannot be provided at the time of initial construction, provide two separate services to the building and provide multiple transfer switches.
- a. Obtain one service from the University electrical system and the other from Detroit Edison.
 - b. Do not obtain both services from the University electrical system because both services will be connected together at times for system maintenance or load balance.
 - c. Do not obtain either service from a 4.8kV or 2.4kV primary circuit because these circuits are being phased out.
 - d. Do not obtain both services from Detroit Edison unless they originate at different Detroit Edison switching stations.
 - e. The University's long-range goal is to provide emergency and standby power to every high-rise building from engine-generator sets. Design the electrical distribution system so that an engine-generator set can be connected in the future.
4. In low rise and high rise buildings with special needs, special power may be required by codes or may be requested by the Owner for hazardous labs, animal rooms, freezer farms, radio transmitters, telecom switching stations or other critical loads.
- a. When possible, provide the special power from the same natural gas fueled engine-generator set that supplies the emergency and standby power. Use a separate automatic transfer switch to feed the special loads.

- b. If no engine-generator set exists and special power is required within minutes of a loss of normal power, provide a dedicated natural gas fueled engine-generator set.
- c. If no engine-generator set exists and special power is required within a few hours of a loss of normal power, provide a University standard generator connection box for connecting a portable generator.

Electrical System Requirements

Distribution Network

The University's long-range goal is to convert the entire primary distribution network to 13.2kV.

1. Connect new unit substations to 13.2kV primary circuits, not to 4.8kV or 2.4kV circuits.
2. Coordinate with the Utilities and Plant Engineering Department to establish the specific circuits and connection points.

Unit Substations

Provide indoor unit substations consisting of primary load break switches, dry type transformers, and secondary switchgear distribution sections.

1. Provide double-ended substations with two main and one tie secondary circuit breakers Double-ended substations are typically only used for health care, and research buildings.
2. Provide single-ended substations with main secondary circuit breaker Single-ended substations are used for classroom, library, housing facility, and similar buildings. With single-ended substations provide a generator connection box on an exterior portion of building accessible to trucks. Also provide raceway and conductors from the generator connection box, to a separate circuit breaker in the substation dedicated for this generator connection.
3. Substations with a secondary voltage rating of 480/277-volts, three phase, 4-wire, are preferred.
4. Size substations only for the anticipated peak load plus spare capacity for future growth. Do not oversize the substations and thus increase initial costs and transformer losses.



UNIT SUBSTATIONS

Scope

Unit substations shall be 500 kVA minimum, 1500 kVA maximum unless approved otherwise by the University. For the required configuration of University substations see Standard Electrical Detail 16313001 for single-ended substations and Standard Electrical Detail 16313002 for double-ended substations,

A system fault contribution of 750 mVA shall be used when determining the required interrupting rating for unit substation equipment.

In general, size a unit substation so that the transformer's AA rating (or the combined transformer AA ratings in a double-ended unit substation) equals roughly 150 percent of the projected peak demand.

Rooms or vaults for indoor unit substations shall be adequately ventilated for equipment cooling, and adequately sound-proofed to significantly reduce the transmission of sound to adjacent areas.

All bus bars shall be copper. All bus connections shall have at least two bolts

All medium voltage insulators shall be porcelain or cyclophatic epoxy

Provide rear access to all unit substations.

Provide drip shields for unit substations installed in areas with fire protection sprinkler systems.

Feeder breakers shall be 800-ampere minimum.

All incoming cable connectors shall be compression type, with NEMA standard lugs and bolt spacing. Two-bolt or 4-bolt connectors are required for each connection.

Incoming Line Section Requirements

Provide incoming line sections with two loop switches for the two incoming lines, and a fused load interrupter transformer primary switch. The transformer primary switch shall be key-interlocked with its associated secondary main breaker so that the secondary main breaker closes after and must be opened before the transformer primary switch.

Provide space for distribution class surge suppressors on each incoming primary line.

Primary switches shall be metal enclosed and rated as follows:

Voltage: 15 kV.

Continuous current: 600 amperes.

Momentary short circuit and fault closing current: 61,000 amperes

Basic Impulse Level: 95 kV

Primary switches shall be two position, of the quick make/quick break type and shall be bottom hinged. Switch mechanisms shall be direct coupled. Chain or cable drives are not acceptable. Exception: Powercon chain driven switches, if supplied as a complete unit (switch, operator, enclosure) by Powercon.

The phase bus bars shall be routed across the top of the switch compartments to eliminate unnecessary transition sections.

All primary cable connections shall be provided with NEMA 2-hole, solderless cable lugs. Allow space in the loop-switch cubicles for stress cones for top or bottom cable entry.

Provide a copper ground bus bar that is connected to the transformer and secondary switchgear section ground bus bars.

Transformer Requirements

Provide only dry type transformers, unless an alternate for a given project is specifically approved by the University.

Transformers (dry type) shall have a 220°C insulation system, and shall be designed for a maximum temperature rise at full load of 115°C above a 40°C ambient.

The transformer coils shall be rigidly clamped to the core. The coil and core assembly shall mechanically and electrically isolated from the transformer frame and enclosure.

Transformers shall have primaries rated 95 kV BIL and secondaries rated 10 kV BIL.

Transformers shall either be equipped with forced air cooling fans and controls, or equipped with needed support equipment and accessories to support future forced air rating fans. The transformers FA ratings shall equal 133 percent times of their AA ratings. Control power transformers supplied with the transformers shall power the fans.

Transformers shall be equipped with temperature switches that start the fans on high (FA operating) temperature and close a dry contact on high-high (alarm) temperature.

The temperature monitor shall be mounted on a hinged front plate of a flush mounted box. The electrical connections shall be accessible and the monitor shall be removable without de-energizing the transformer.

Wiring to the temperature monitor shall be routed and supported independently of the transformer enclosure so that enclosure panels can be removed without affecting the wiring.

The temperature monitor shall include three hot spot temperature sensors, one for each transformer phase.

The temperature monitor shall start the fans at a temperature of 100 degrees C. It shall initiate an audible alarm, close an "alarm" contact, and illuminate a red alarm LED at 135 degrees C. It shall close a breaker "trip" contact and illuminate a second red alarm LED at 175 degrees C. The temperature set points shall be adjustable. The contacts shall be Form C and wired out to a terminal strip inside the box.

The temperature monitor shall include an LED or LCD display to allow reading of the hot spot temperature in each phase, and the highest temperature seen on each phase since the last reset. A reset button shall be provided to reset the maximum readings.

The temperature monitor shall include LED's indicating "power on" and "fans running".

The temperature monitor shall include an RS422 data port for future connection to a remote monitor.

A Hand-Auto control switch shall be connected in parallel with the temperature monitor fan control contacts.

Full capacity, 2.5 percent taps shall be provided on the primary winding, three below, and one above the rated voltage tap (five total taps).

Transformers for the North Campus, initially served at 4800-volts, shall be equipped with dual wound primaries; 13.2 kV and 4.8 kV. The 13.2-kV primary shall be equipped with taps as noted above.

Secondary Switchgear Section Requirements

Provide secondary main breakers in all unit substations. Secondary main, tie breakers, and feeder breakers shall be:

1. Individually mounted, draw out, metal-clad, mechanically operated, stored energy type, quick-make and quick-break air circuit breakers.
 - A. Unless noted otherwise, the breakers shall be manually 'charged'.
 - B. Electrically operated (electrically charged) breakers shall be supplied where called for on the drawings. Each electrically operated breaker shall be powered by a dedicated, charging motor.
2. Breakers shall be equipped with removable arcing contacts and operation counters.
3. Breakers shall be rated for 100 percent continuous duty, with frame and trip (sensor) ratings as shown on the drawings. Sensor size (and design application) will typically be 75%, or more, of the frame size
4. Breakers shall be capable of being manually racked into three positions; "connected", "test" and "disconnected". The breaker frames shall be grounded in all positions.

5. The compartment front doors shall be closable in all breaker positions and shall permit breaker operation with door open or closed. The doors shall be capable of being opened without tripping breakers in the "connected" position.
6. A breaker shall be tripped open and the stored energy in the breaker mechanism shall be discharged as the breaker is moved from one position to another.
7. Breaker compartments shall be deadfront. Shutters shall close automatically as a breaker is racked out of the 'connected' position. Control contacts shall be 'made' when breaker is in test or connected positions.
8. Breakers shall have a minimum of two spare "Form C", isolated contacts brought out to an accessible terminal strip in the compartment. The contacts shall be rated 120 volts, 10 amperes, 60 Hz.
9. Each breaker shall be equipped with three-phase and one neutral current sensor, and a microprocessor-based trip unit.
10. Where shown on the drawings, breakers shall be equipped with a flux transfer shunt-trip. The flux transfer shunt trip wiring shall be terminated on an accessible terminal strip in the compartment.
11. Breakers shall be capable of being padlocked in the "open" position.
12. A Kirk Key interlock shall be provided to prevent the operation of the fused primary switch unless the main breaker is open.

Each breaker shall be equipped with RMS sensing trip units as noted below.

1. Solid-state trip units shall be true RMS sensing, with trip ratings adjustable by removable rating plugs. The trip units shall be magnitude and time adjustable, and shall include a local indication of the cause of a trip. The trip units shall be rated as shown on the drawings.
2. The trip units shall coordinate with the primary fuses, main breaker and largest downstream feeder breakers.
3. The trip units shall allow adjustment without breaker trips and routine testing without removing the breakers from service.
4. The trip units (sensors) shall be rated for 100 percent continuous duty.
5. Trip units shall provide the following ranges and functions as a minimum. See drawings for specific requirements that vary from this configuration:
 - A. Long time (L) current settings of at least 50-100 percent of the current sensor rating, divided into seven or more steps, and time delays of at least 2-22 seconds, at 600 percent of the long time current setting, divided into seven or more steps.
 - B. Short time (S) current settings of at least 250-1000 percent of the long time current setting, divided into seven or more steps, and time delays of at least .1-.5 seconds, divided into seven or more steps, to include "flat response" and "I²T response" characteristics.

- C. Instantaneous (I) settings of at least 200-1000 percent of current sensor rating. The instantaneous setting shall be applied on the feeder circuit breakers only, not on the main breaker.
 - D. Ground fault (G) current settings of 25-100% of current sensor rating, with a 1200 ampere maximum, divided in seven or more steps, with ground fault time delay settings of at least .1-.5 seconds, divided into five or more steps, to include "flat response" and "I²T response" characteristics.
6. Power for operating the solid state trip unit shall be obtained from within the circuit breaker assembly itself, or it shall be provided by a separate control circuit connected to the secondary bus ahead of the main breaker. The solid state trip units shall have non-volatile memory to maintain all settings, trip indications and fault data during a power outage. Batteries to maintain the memory are not acceptable.

The A/E shall design the overcurrent protective system so it can be set in a 'selective' manner, to minimize the disruption from any given fault, to as small an area as possible. The A/E shall also prepare, and/or approve the settings for the overcurrent protective system to insure proper selectivity and coordination. The contractor shall provide test reports showing that the overcurrent system has been set and tested, before the system is commissioned

In double-ended unit substations, the two main breakers typically are interlocked with the tie breaker so that all three breakers can not be closed at the same time. The throw-over is normally done manually, unless noted otherwise

Provide ground fault protection on all breakers rated 1200 amps or more. Avoid providing unnecessary ground fault protection that may cause nuisance outages.

Bus bars shall be braced for the calculated short circuit current.

Provide a voltmeter with selector switch, and an ammeter with selector switch. Selector switches shall have also off position.

Provide a Power Measurement Limited (PML) 7330 ION three phase power, energy, demand, and harmonics meter for each transformer secondary. The PML meter shall be panel mounted with an FT (Flexi-Test) case at 60 inches above the finished floor. The meter shall be provided with an Ethernet port.

Installation Requirements

Instruct the Contractor to perform testing and do settings in accordance with manufacturer instructions and Section 16950, and to provide the University Project Coordinator with a test report. University will supply circuit breaker settings, and primary fuse sizes.



LOW VOLTAGE ELECTRICAL DISTRIBUTION

Scope

New distribution systems shall be 480/277 volts AC, and/or 208/120 volts AC, three-phase, four-wire (w/ground), unless otherwise directed by University Design Manager (UDM).

The A/E shall perform a fault and coordination study to the depth needed to insure that the specified devices will properly and safely interrupt faults and overloads, and that the system can be coordinated properly.

All breakers, fuses and electrical distribution equipment shall have interrupting ratings of at least 1.2 times the available fault current as determined by a fault current analysis performed by an engineer.

All relays, breakers, fuses, and other overcurrent protective devices shall be coordinated in order to protect electrical equipment from damage and to isolate the fault to the smallest possible portion of the distribution system..

All fault current and coordination studies (not performed by the A/E) shall be approved by the A/E before equipment energization. The approved fault current and coordination studies shall be provided to the University Project Manager (UPM) before commissioning of the distribution system can proceed.

Switchboard and Panelboard Requirements

All switchboards and panelboard breakers shall have the appropriate short circuit interrupting rating as determined by the fault current analysis. All switchboards and panelboards shall be of the safety dead front type and ruggedly constructed of sheet steel. All switchboard and panelboard doors shall have latches in addition to locks and shall be master keyed alike. All switchboards and panelboards shall have an identity designation and shall include its source identification and location. All loads shall be identified by number and load (where applicable) and a typewritten load schedule shall be protected by clear plastic and placed in a frame mounted to the inside of the door.

All breakers requiring settings such as long time pick-up, instantaneous pick up, etc. shall be set according to a coordination study performed by an engineer. The coordination study shall be submitted and approved by the project A/E before any equipment energization. The approved settings shall be placed on the breakers and records of the approved settings and coordination study shall be provided to the UPM before job closeout/ commissioning.

At job closeout, all switchboards, and panelboards, shall have a minimum of 25 percent spare capacity - split equally between breakers spares and breaker spaces.

All current carrying parts shall be 98 percent conductivity copper and the phase buses shall be 100% rated throughout. Where a neutral bus is required (4-wire systems), it shall be 100% rated and isolated (unless it is required by the NEC to be bonded to ground, such as in the case of service equipment). The equipment ground bus shall be rated at a minimum of 50% of the phase bus capacity. Both the neutral and ground buses shall have sufficient terminals to accommodate the number of poles or devices that can be installed.

The main and feeder protective devices shall typically be bolted to the bus. Square-D, I-Line panels are an exception.

Indoor panelboards, switchboards, and safety switches, are to be NEMA 1. In areas where water spray or high humidity will be present (like a room needing occasional wash downs) use NEMA 4. Typical outdoor applications shall be NEMA 3R. In cooling towers, parking structures, or areas where water spray and/or high humidity will be present, use stainless steel NEMA 4. For other special locations, provide equipment that has NEMA type enclosures as required by the NEC.

Panelboards

Panelboards with mains (circuit breaker or fused switch) shall have these devices installed at the top or bottom of the bus. They shall not be mounted on the side like a feeder device.

In cases where significant neutral currents may be present due to non-linear loads, the panelboard shall be provided with a 200% rated neutral bus bar; the panelboard feeder neutral shall be sized at 200% and the source transformer shall be rated appropriately to serve non-linear loads (high harmonics) with a minimum K-rating of 4

For special systems, provide bus bars meeting those special system requirements.

Panelboards shall have wire gutters sized to accommodate the bending radius of all wires when fully equipped and shall not be less than 4 inches wide.

In general, panelboards in finished areas shall be flush mounted. Panelboards in electrical, mechanical and other service rooms and spaces may be surface mounted.

"Loadcenter" type panelboards are not acceptable unless specifically approved by the UDM for the specific and/or unusual application.

Switchboards

Wherever space permits, switchboards shall be of the fused switch type and equipped with peak current limiting fuses, (unless engineering requirements dictate other fuse types) so that fault current can be minimized. Where space is not available for the larger enclosures of fused switches, circuit breaker switchboards may be utilized.

Mount switchboards, whenever possible, in areas accessible only to qualified electricians. In those locations the switchboards do not need to have a door. In areas accessible to other than qualified electricians, provide a door.

In general, switchboards in finished areas' areas shall be flush mounted, in electrical, mechanical and other service rooms and spaces they may be surface mounted.

Safety Switches

Safety switches shall be fused or unfused as needed. Handles shall have provision for padlocking. In addition, safety switches shall include a maintenance bypass (open door while hot) provision.

Provide ground connection point in all safety switches. Provide neutral bar where circuit is 4-wire.

Safety switches on load side of Variable Speed Drives shall have auxiliary contacts to de-energize VSD before opening safety switch (Form C). Certain applications may require more than one auxiliary contact.

All safety switches shall be "Heavy Duty" rated.

Distribution Transformers

Generally, building distribution transformers shall be of the 480-208Y/120 volt type. Transformers shall be of the dry type, with a 220 degrees C insulation system, and designed for a maximum temperature rise at full load of 115 degrees C above a 40 degrees C ambient.

Provide terminals compatible with copper terminations and having holes drilled to accept NEMA 2 or 4-hole terminals as is appropriate for the size of the transformer. Provide a ground connection bar (or device) to accommodate at least 4-NEMA 2-hole terminals.

Transformers shall have a sound rating 3 dB below NEMA standard (42 dB for 10-50 kVA, 47 dB for 51-150 kVA, 52 dB for 151-300 kVA and 57 dB for 301-500 kVA rated transformers). As a first preference, transformers should have 6 adjustment taps, two 2 ½ percent above and four 2 ½ percent below nominal voltage. If this setup is not readily available, four adjustment taps, two 2-1/2 percent above and two 2-1/2 percent below nominal shall be acceptable.

Where substantial non-linear loads are to be served, the appropriate K-rated (K-4 minimum) transformer shall be used.

Provide vibration pads for the transformer supports.

Distribution System Requirements

Substation secondary distribution breaker frame size shall be 800 A. The minimum sensor rating shall be 800 A, which can be set to 50 percent to produce a minimum 400 A breaker rating. Exemptions to these ratings will be permitted for feeds to emergency systems.

The first tier of distribution panels downstream of the substation shall be of the fused switch type and equipped with peak current limiting fuses, (unless engineering requirements dictate other fuse types) so that fault current can be minimized.

Provide required working space according to the NEC article 110 for motor disconnects and all other electrical equipment.

All outdoor disconnects and associated electrical equipment for cooling towers shall be stainless steel and NEMA 4 rated.

Provide NEMA Type 6-20R 250 volt, 2 pole, 3 wire, 20 amp receptacle outlets on a 208 volt, single phase circuit where required for large freezers or other large appliances. All wiring for these receptacles shall be No. 10 AWG minimum so that the circuits can be upgraded later to 30 amps if required.

Provide 120 volt duplex receptacle outlets on both side walls of corridors and hallways at intervals not exceeding 20 feet.

Provide a 120 volt duplex receptacle outlet at each stairwell floor landing.

Provide a minimum of one 120 volt duplex receptacle outlet per each 100 square feet, or any fraction thereof, in each mechanical, electrical and janitorial closet.

Provide ground fault circuit interrupter (GFCI) protection for all 120 volt receptacle outlets located outdoors, in toilet areas and within 6 feet of water sources. No receptacles shall be rendered GFCI by being fed from the load side of a GFCI. Water coolers do not require GFCI and shall be fed from a simplex receptacle.

Installation Requirements

The Contractor shall provide at least five working days notice and shall coordinate service interruptions with the University Project Manager. The University must approve each service interruption in writing.

Before closeout/commissioning the contractor shall:

- Comply with all applicable codes and standards.
- Install all wiring in approved raceway.
- Install a separate equipment grounding conductor with the phase conductors in the raceway.

- Provide exothermic welded connections or *Burndy High Ground* compression connection between the Grounding Electrode Conductor and any Grounding Electrode.
- Install all distribution equipment at a height that will not place the top unit operating handle more than 6 feet and 6 inches above the finished floor.
- Identify all receptacles with circuit number and source panel.
- Identify all installed switchboards and separately mounted circuit breakers, panelboards, motor starters, disconnect switches, relays, and all other equipment used for the operation and control of electrical equipment by means of engraved laminated plastic (or equivalent) plates permanently affixed to the equipment. The information provided shall contain the identification number/label of the equipment and its power source identification and location.
- Identify all panelboard circuit breakers with permanently fixed numbers and a typewritten directory identifying the breaker loads mounted in a frame affixed to the interior of the door and protected by clear plastic.
- Perform testing in accordance with Section 16950 and provide the UPM with acceptable test reports.
- Provide all engineered coordination and short circuit studies to the UPM.
- Provide all one-lines, riser and as-built drawings to the UPM.



Wiring Devices

Scope

All wiring devices shall be UL -extra-heavy duty. See Preferred Manufacturer's List for specific information on acceptable products.

Devices shall have a minimum rating of 20-amperes.

Wiring devices connected to 'normal power' shall be supplied in the manufacturer's standard color closest to 'Ivory', unless noted otherwise. If Ivory is not available, in special application devices, use the manufacturer's standard brown.

Wiring devices connected to 'emergency power' shall be supplied in the manufacturer's standard color closest to 'Red', unless noted otherwise. If red is not available in special application devices use the manufacturer's standard ivory or brown. Exception: 'Special Power' receptacles installed in the Medical School shall be gray.

When multiple circuits serve a series of receptacles the circuits shall be alternated so adjacent receptacles are not on the same circuit.

Receptacles shall be installed so the ground terminal is below, or to the left of the neutral terminal. If the building standard is other than this, follow the existing building standard

All receptacles and switches shall be labeled to note the source of power.

Receptacles within 6-feet of a water source shall be GFCI type. Receptacles dedicated to sump pumps and water fountains are excluded.

GFCI receptacles shall not be wired to protect downstream standard receptacles. Each GFCI, when it operates shall only interrupt 'its own' receptacles

Coverplates shall be 'high-quality', Type 302, stainless steel unless noted otherwise.

'Futura' class devices shall not be used, unless the needed device is only available in that style, or otherwise noted.

Lighting Controls

A. General

Toggle switches shall be rated 120/277 volts, 20-amperes, single-pole, double-pole, 3-way, or 4-way as required

Dimmer switches shall be rated 1000 watts minimum, specification grade, heavy duty, with radio noise filter - UL listed for 'heavy duty' use.

Lighting control switches, serving areas 'not visible' at the switch location shall have a pilot light function.

B. Occupancy Sensors

1. Wall mounted occupancy sensors shall be rated 600 watts minimum, 180 degrees coverage, 300 sq. ft. minimum coverage, infrared type
2. Ceiling mounted occupancy sensors shall be rated 1000 watts minimum, 180 degrees coverage, 1000 sq. ft. minimum coverage, infrared type,
3. All sensors shall have adjustable range or sensitivity, and adjustable time delay.
4. Ceiling mounted sensors (especially) shall utilize low voltage control circuits and be interlocked with the switch circuit for local auto/off control.
5. Dual technology occupancy sensors shall be used in applications where false operations must be minimized. These dual technology devices shall have a power ratings of at least 1000 watts load rating, shall cover at least 180 +/- degrees (from device), 1000 sq. ft. +/- coverage, and combination ultrasonic/infrared type. The ultrasonic component shall be of a frequency compatible with hearing aids.
6. Occupancy sensors shall be of a type that does not make any noise when the sensors switch from the on state, to the off state.
7. NOTE: Some ultrasonic occupancy sensors operate at frequencies that interfere with proper hearing aid operation. Any ultrasonic sensors shall therefore be specified to operate beyond the interference frequencies with hearing aids.

C. Light Dimming Control Systems

1. The wiring devices, as applicable for the dimming system, shall be in accordance with the above requirements.
2. Such systems shall be placed, labeled, and configured to be 'user friendly and intuitive. See Section 16550 for more information.

D. Lighting control systems

1. The wiring devices, as applicable for the lighting control system, shall be in accordance with the above requirements.
2. Such systems shall be placed, labeled, and configured to be 'user friendly and intuitive. See section 16550 for more information.

Receptacles

Duplex and single (simplex) receptacles shall be rated 125 volts, 20 amps, 2-pole, 3-wire, NEMA Type 5-20R.

GFCI duplex receptacles shall be rated 125 volts, 20 amps, 2-pole, 3-wire straight blade type with nylon or Lexan bodies. GFCI receptacles shall trip when ground currents exceed 5-mA, shall trip in 25-milliseconds maximum, and shall have an interrupting rating of 2000 amperes.

TVSS receptacles shall clamp at 330 volts or less, and shall have visual indication of the failure of their protective circuitry.

Child resistant receptacles shall require the simultaneous insertion of both line and neutral plug blades before power is applied to the receptacle contacts.

'Special receptacles' shall be of the voltage, amperage, number of poles, number of wires, configuration, and NEMA Type required by the (to be) supplied load.

Ceiling mounted and/or critical application receptacles shall be 'twist-lock' type with the NEMA configuration required for the (to be) supplied load.

'Receptacle Strips'

Commercially available surface mounted receptacle strips shall not be used unless the receptacles meet the above noted minimum requirements. Alternately, use surface raceway with receptacles separately installed. The receptacles shall be spaced as required for the application.

Power Poles

Power poles shall be painted steel unless shown otherwise, with an internal barrier to separate power wiring from telecommunications wiring. If power outlets are installed they shall meet the minimum requirements noted above. A green ground wire shall connect all receptacles. The pole shall not be used as the ground conductor.

The poles shall be firmly affixed at the top and bottom. The power and/or telecommunications wiring shall exit the poles through separate flex conduits connected to ceiling mounted junction boxes

Floor Boxes

In general, floor boxes shall be avoided. When there is no good alternative, however, the boxes shall be of the 'Flush-Poke-Thru' type, with multi-service capability, and be UL listed for 2-hour fire resistance.

Boxes shall have a minimum capacity of 30 cubic inches, split into 2 or 3 compartments of equal capacity by removable partitions

These 'Flush Poke-Thru' type floor boxes shall meet ADA and Accessibility Guidelines and be UL listed for scrub water exclusion.

Multi-service devices shall have the necessary channels in the insert body to provide complete separation of power & communication services.

Pin And Sleeve Connectors

Pin and sleeve connectors shall comply with IEC Standard 309. They shall consist of nylon housings with integral locking rings and cord grips that are color coded by voltage. Pins and sleeves shall be sized, arranged, and keyed to prevent incorrect assembly.

Timers

A. General

1. Acceptable manufacturers are noted in the Preferred Manufacturers List.
2. All devices shall be UL listed and labeled for the application
3. Inside mounted devices shall have a NEMA 1 enclosure. Outdoor applications shall have a NEMA 3R enclosure. In either case, the cover shall be lockable.
4. Controls shall be easy to understand, and adjust.
5. Power control contacts shall be provided, capable of switching 20-ampere, 120 or 277-volt circuits. These contacts shall be capable of controlling incandescent, fluorescent, or HID lighting.

B. 24-Hour and 7- Day Timers.

1. Where BAS control panels are not available, or too expensive to upgrade, install timers.
2. Timers shall be electronic type, with battery back up and appropriate charging circuits to keep the battery charged. The battery shall supply only the internal date, and time circuitry.
3. Timers for control of indoor lighting applications shall include automatic switching to accommodate daylight savings time changes, standard holidays, and special other specific dates.
4. Timers for control of outdoor lighting applications shall include astronomical type of controls to automatically adjust on and off times to accommodate time of year.
5. Two or more power control contacts shall be provided, as noted above.
6. Provide at least one, Form C, control contact rated for 120-volts.

C. Spring Wound Timers

1. Where an application requires a timer, to allow an erratically scheduled 'On Times' of a specific length, use manually, spring wound, timers.
2. Timer shall allow 3-way switching of lights, i.e. control of tunnel lighting from either end of the tunnel segment.
3. The construction of the timer shall be appropriate for the environment where it is to be used, i.e., hot and high humidity environments in tunnels.

Installation Requirements

- D. Provide No. 10 AWG wire to NEMA Type 6-20R receptacles serving freezers, window air conditioners, or other large appliances.
- E. Where circuits are supplying a high portion of non-linear load, provide a separate neutral conductor for each single-phase branch circuit. The neutrals of these single-phase circuits shall not be shared or daisy-chained.

- F. Provide ground fault circuit interrupter (GFCI) receptacles for new and existing 120 volt duplex receptacles located outdoors, in toilet rooms and within 6 feet of water sources including sinks, cup sinks, fume hood sinks, faucets, hose bibs and water coolers. Standard receptacles protected by an upstream GFCI receptacle or a GFCI circuit breaker is not acceptable.
- G. Provide waterproof enclosures for duplex receptacles located outdoors. Enclosures shall remain watertight even while in use.
- H. Provide a label on the cover plate of new, or existing, light switches and receptacles in the project area. Identify the panel and circuit number feeding the device. Embossed plastic tape labels are not acceptable.
- I. Color code junction boxes and box covers of emergency circuits with red paint.
- J. Mark lighting and power junction box covers in indelible ink with the panel and breaker numbers of the circuits contained within.



MOTOR CONTROLS

Scope

In general, motors larger than 1/3 horsepower shall be 460 volts or 208 volts, 3 phase. Motors 1/3 horsepower and smaller shall be 115 volts, single phase. Motors 200 horsepower and larger may be rated for medium voltage 2,400-volts, 4,160-volts, or 4,800-volts.

When both 480/277-volts and 208/120-volts are available in a given building, connect and run all 3-phase motors at 480/277-volts.

Especially when only 208/120-volts is available in a building, carefully evaluate the degree and frequency of motor-starting voltage-drops, on the other systems in the building. Where the 'flicker limits' noted in utility system (DTE's) rate/rule books (or good engineering practice) would be violated, install 'soft starters', variable frequency drives, or other means for reducing the voltage-drop during motor-starts.

Provide a motor control center (MCC) to control motors clustered in a given area or zone of the building. Provide local (individual) combination motor starters to control one, or a small number, of motors in a given area or zone.

Avoid feeding 3 phase motors from lighting or receptacle panels. Use 'power panels', available in the building, whenever possible.

Design motor feeder circuits to limit the motor starting and running voltage drops to values within the requirements of the NEC.

Motors 50 HP and larger shall be provided with power factor correcting capacitors.

- If a VFD is the motor controller, evaluate whether or not a capacitor should be installed given the distorted waveforms often present with VFD's.
- If only 208/120-volts is available in the building, and all 3-phase motors are therefore 208-volt, evaluate and then address the affects of the non-linear loads connected to the system (computers, UPS systems, etc.)

A duplex work receptacle shall be in close proximity to all motors and motor controllers.

Distribution systems and motor feeders to 'duplex' systems shall be sized to operate both motors simultaneously - even if current plan is only operate one at a time.

Motor Controllers

Provide electrically operated, motor controllers to provide short circuit and motor overload protection, and motor disconnecting means, for all three-phase motors.

Single phase motors may be controlled by manual motor starters.

Starters shall be lockable in the open (preferably in open and closed) positions.

Combination motor starters, with fused switches, are preferred whenever possible (for their visible break).

Variable Frequency Drives, and Reduced Voltage Starters

When variable frequency drives (VFD) are specified (these are normally specified by mechanical engineer), the drive should be supplied with a disconnecting means. If none is supplied (specified), a separate disconnection means shall be provided - at the VFD. If VFD is not in line of sight of motor, or is not lockable in the open position, install a non-fused disconnect switch at the motor. That disconnect shall have 'pre-break' contacts. If the VFD controller needs this pre-break contact, wire this contact to the VFD. These control wires for the pre-break, may be run in the same conduit as the motor feeder.

Provide reduced voltage or soft motor starters when full voltage motor starting may affect voltage sensitive equipment on the same bus.

Disconnecting Means Needed in Line of Sight of Motor

If motor control (starter) disconnecting means is not in line of sight of motor, or is not lockable, provide a lockable, non-fused safety switch at the motor. (This requirement applies to all types of motor control equipment.)

For critical motor loads such as many fume hoods, provide motor single-phasing-protection. Single phasing protection shall be accomplished by the use of a 'single phase detector' on a fused disconnect, or by the use of a molded case circuit breaker.

Control Circuit Requirements

In general, provide 'Hand-Off-Auto' (HOA) control switches for motors 1/2 horsepower and larger (including those controlled by variable speed drives). In the "hand" position, the motor shall run independently of most automatic start/stop controls. Only the safety and modulating controls shall remain active. In the "auto" position, all start/stop controls shall be active. Wherever possible, control circuits shall be wired so that motors automatically restart after a power disruption. Provide time delays to allow large fans and pumps to coast down before restarting after a momentary power disruption, and to prevent all of the large motors from restarting simultaneously.

High temperature detectors (firestats), smoke detectors, low temperature detectors (freezestats), flow switches and all other safety controls shall be energized and operational whenever the equipment they protect is operating.

When required, provide limit switches on dampers to prevent the associated fans from starting until the dampers are fully open.

Duct smoke Detectors

Duct smoke detectors required by code.

- Duct Smoke detector shall be supplied by, installed, and wired by the fire alarm system supplier. This detector shall be compatible with that fire alarm system.
- When fire alarm system is 'intelligent', do not directly control motor from smoke detector. See detail 16720006 noted below.
- Wire those duct smoke detector to the 'Duct Smoke Detector Interface Box' as shown on details 16720008 (for buildings without fire alarm systems, 16720007 (for buildings with 'hard-wired' fire alarm systems), or 16720006 (for buildings with addressable fire alarm systems). These interface boxes allow quicker isolation of equipment failures to either the temperature control system or the fire alarm system. Interface boxes are available from Owner.
- Fire alarm contractor and temperature control contractor will wire to these interface boxes, and test them for proper operation.
- The interface box(es) should be close to the temperature control panels.

Equipment Requirements

Medium voltage motor starters shall be of the vacuum breaker type. Coordinate the selection of medium voltage motor starters with the University Utilities Department through the University Project Coordinator.

Each MCC motor starter or combination motor starter shall consist of a fused disconnect switch or molded case circuit breaker, a magnetic motor starter with 1 overload relay per phase, and a control power transformer. Fuses shall be of the dual element, time delay, rejection type. Fused disconnects are preferred since they provide a 'visible break'.

Provide drip shields for motor control equipment installed in areas with fire protection sprinkler systems.

Installation Requirements

Instruct the Contractor to perform testing in accordance with Section 16950, and to provide the University Project Coordinator with test reports.



VARIABLE FREQUENCY DRIVES

Scope

For the purposes of these guidelines, the terms variable speed drive and VSD, can, and may be used interchangeably with the terms variable frequency drives and VFD

This electrical guideline, in large part, deals with the installation of VSD. For information dealing with the drives themselves refer to the mechanical guidelines, Section 15960.

Safety disconnect switches are not required at the motor, when the line disconnect of the VSD is lockable, and within sight of the motor. When the VSD line disconnect is not lockable, or is not in line-of-sight, a separate safety disconnect shall be installed at the motor location. All safety disconnect switches shall have pre-break (auxiliary) control contacts, (even if they are not specifically required by the VSD supplier). The wires for this control contact shall be run in the same raceway as the power conductors.

All wiring and grounding shall be in accordance with the associated electrical sections dealing with these requirements.

Harmonic Distortion Considerations

Before adding a VFD, determine the total harmonics generating load on the unit substation transformer. The new harmonic generating load shall not exceed 10 percent of the transformer base rating without approval from the University Utilities Department through the University Project Coordinator. Harmonic generating loads, as defined here, include electronic ballasts, computers and their peripherals, solid state power supplies, UPS systems, VSD drives, etc.

If the total load on the transformer, after the additions of the current project, exceed 75% of its rating; and/or if the total harmonic generating load on a substation will exceeds 50%; the A/E shall prepare a study for review by the University showing that the transformer can safely carry those loads. If the study shows the transformer inadequate, the project shall either increase the transformer size, or add additional transformers. Before adding a VSD, evaluate the possible effects of the VSD on power factor correcting capacitors or harmonic sensitive equipment on the same bus. Avoid installing a VSD on the same bus with capacitors or 'sensitive' equipment. Sensitive equipment, as defined here, are loads adversely affected by harmonic voltage distortions. These include, high sensitivity laboratory equipment, patient monitoring or treatment equipment, computers, etc.

Provide calculations per IEEE Standard 519 showing the current and voltage total harmonic distortion (THD) that will be reflected into the existing University power system, for any load exceeding 10% of the rating of the transformer serving it. Contact the University Utilities Department through the University Project Coordinator for the required power system data.

The VSD shall limit the THD to the values noted below when operating at any load from zero to 100 percent.

- VSD input voltage waveform: less than 3 percent THD
- VSD input current waveform: less than 100 percent THD

After startup of the VSD, the mechanical contractor shall provide, and the electrical contractor shall install, at no additional cost to the University any additional reactors or filters required to reduce the actual THD to the calculated THD.

Maintenance Bypasses

All VSD's for motors larger than 5 HP, and/or on systems serving critical loads (as defined in program statement, shall include full maintenance bypass systems. These bypasses shall be configured to allow operation of the motor; 'across the line' mode while the drive is being repaired. Also, the bypass equipment shall be electrically isolated from the VSD drive equipment so that maintenance may be safely done with the motor running 'across the line' in through the bypass.

The electrical system serving a VSD, and the mechanical system being served by the VSD, shall be sized and braced to allow that motor (and associated mechanical system) to start and operate properly and safely when in the bypass mode - across the line. Special attention needs to be given to the affects of the voltage drops during start and the ability of the upstream overcurrent devices to carry the locked rotor current during the startup.



HEATING CABLES AND MATS

Scope

Provide heating cables and mats to protect outdoor piping and tanks from damage due to cold weather. When required, provide heating cables and mats to prevent ice buildup on and damage to concrete slabs, roofs, gutters, and downspouts.

Provide self-regulating heat tracing products manufactured by Raychem Corporation, Process Division, Menlo Park, California or Thermon Corp, 100 Thermon Dr., P.O. Box 609, San Marcos, TX, 78667-0609.

Equipment Requirements

Provide Raychem model "Autosense M-Wire" or comparable Thermon model for protection of critical water lines (such as exposed chilled water pipes serving a computer room A/C unit).

Provide Raychem model "BTV" or comparable Thermon model for protection of non-critical hot and cold water lines (such as exposed chilled water lines to a local air conditioning unit serving a general occupied zone).

Provide Raychem model "XTV" or comparable Thermon model for steam service.

Provide Raychem model "ElectroMelt" or comparable Thermon model for concrete snow-melting and de-icing applications.

Provide Raychem model "IceStop" or comparable Thermon model for roof and gutter snow-melting and de-icing applications.

Get written approval from University Project Manager if the necessary product cannot be provided by Raychem or Thermon.

Sizing Requirements

Use the Raychem application software such as "TraceCalc" etc. or comparable Thermon application software to size and determine the heating cable wattage density and trace ratio (wraps per linear foot). For applications not covered by software, use the approved method as outlined in Raychem's or Thermon's applicable design guide publication.

Monitoring and Control Requirements

When available, the Building Automation/Direct Digital Control (BAS/DDC) System shall provide all control and monitoring functions. If BAS/DDC is not available, get direction

from the University Project Manager. Contact University Project Manager to determine if heat trace system monitoring is necessary or desirable. Monitoring functions shall be accomplished through current sensing switches (CSS) that monitor each electrical feed phase. When providing systems with an integral monitoring conductor, contact University Project Manager for monitoring conductor connections.

Installation Requirements

Heating cables and mats shall be installed according to the manufacturer's instructions. All installations shall comply with the NEC and particularly articles 426 and 427 of the 1999 and 2002 NEC, which apply to this equipment. Per article 426-28 and 427-22, the system shall be protected by a 30mA trip ground fault protection of equipment device.

The contractor shall test the heating cables and mats in accordance with this Design Guideline, DG Section 16950 and manufacturer's recommendations before energizing or installing any insulation or covering. Contractor shall provide the University Project Manager with test reports before job closeout

Insulation Resistance (Megohmmeter) Testing for Heat Trace Cables

- A. Refer to manufacturer's Design, Installation, and Maintenance Guide.
- B. Perform megohmmeter test at 2500v dc.
 - i. Measure the resistance between the heating cable bus wires and the grounding braid.
 - ii. If the heating cable is installed on a metal/conductive surface, apply megohmmeter between the grounding braid and the surface.
 - iii. Apply the voltage for one full minute.
 - iv. All insulation resistance values should be greater than 1000 megohms.
 - v. Resistance reading should stabilize.
 - vi. If any of the above conditions cannot be met contact the Project Manager.
- C. Perform megohmmeter testing prior to installation and after installation of heating cables, but prior to power connections.



ENGINE-GENERATOR SYSTEM

Scope

When required by code or to satisfy a special program requirement, provide a natural gas fueled engine-generator system. The University considers the probability of a simultaneous failure of both the natural gas utility delivery system and power from the outside electrical utility to be low. Provide a diesel engine-generator system only when a hospital code or the performance requirements cannot be met using a natural gas fueled system.

Related Sections

U-M Design Guideline Sections:

[SBA-J – Fire Command Center](#)

[210000 – Fire Protection](#)

[230060 - Mechanical Sound and Vibration Control](#)

[230900 – Mechanical Systems Controls](#)

[260526 – Grounding and Bonding for Electrical](#)

U-M Master Specification Sections:

[231123 – Natural Gas Systems](#)

[263000 – Engine-Generator System](#)

U-M Standard Details:

[260000 Series - Electrical Standard Details](#)

Reference Documents

Environmental Protection Agency (EPA) emissions standards for stationary internal combustion engines

NFPA 37, "Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines"

NFPA-110, "Standard for Emergency and Standby Power Systems"

UL 1008, "Standard for Automatic Transfer Switches"

UL 2200, "Standard for Stationary Engine Generator Assemblies"

Design Requirements

Use U-M Master Specification 16231 to specify the engine-generator and associated automatic transfer switches and accessories. Edit Specification 16231 to make it project specific. Turn on hidden text and follow the Spec Editor notes when editing the specification.

Arrange for studies to determine how the unit's sound, vibration and effluent will impact the building and surrounding buildings. Perform these studies early in project design to avoid last minute design changes. See Design Guideline 15240 for applicable sound and vibration limits.

Divide the generator's emergency and standby loads into multiple blocks of load. Sequence the load blocks to start at least 10 seconds apart. Avoid starting more than 50 percent of the generator's full load at one time.

System Requirements

Provide a stationary, standby-rated engine-generator unit with automatic transfer switches, load testing means, and accessories in compliance with NFPA 110 Level 1 and UL 2200. The system shall be designed for full load operation in a Seismic Category A area over a temperature range of minus 22 degrees F to 104 degrees F at an elevation not exceeding 1,000 feet above sea level.

Provide a factory EPA Certified engine to meet the current EPA exhaust emissions standards for engine-generators operated no more than 500 hours per year and no more than 100 hours per year in a maintenance/test mode. When a factory EPA Certified engine is not available, the engine shall be EPA Compliant Capable and the supplier shall provide the first field certification of EPA emissions compliance as part of the field start-up and performance testing.

Evaluate locating the engine-generator in a room versus locating it in an outdoor enclosure.

- Consider initial cost, ease of maintenance, ease of major component replacement, fuel and exhaust piping routes, heat rejection, feeder cable lengths, sound, vibration, etc.
- For non-Regental projects, obtain Exterior Elements Design Review Committee approval before locating a unit or exhaust stack outdoors where visible to the public.

Specify the unit's maximum physical size. Specify its maximum allowable sound (including the load bank) and maximum allowable vibration based upon the sound and vibration studies.

Evaluate the need for an 800 amp generator backfeed tap box to connect a portable engine-generator to an 800 amp unit substation feeder breaker during unit substation maintenance. If required, design the tap box in accordance with Standard Detail 16313004. Locate the tap box at the loading dock or where a portable generator can be parked adjacent to it.

When multiple units are being provided and they will be operated in parallel, the engines shall utilize the same fuel type and the generators shall be wound with a 2/3 pitch.

When multiple units will be operated in parallel, divide their loads into multiple blocks, prioritize them and control them so the highest priority blocks receive power even if one unit fails.

Engine-Generator Sizing

Size the unit based upon its 100 percent standby rating.

Size the unit using generator sizing software from one of the specified manufacturers. Provide sufficient capacity to start the unit's largest block of load while all other loads are running, without exceeding the specified maximum voltage or frequency drop.

Provide 25 percent spare capacity above the peak projected load to feed future growth.

Engine-Generator Load Testing

For units under 1,000 kW, load testing shall be performed using a resistive load bank.

- For an outdoor unit in an accessible location on grade, the Plant Electrical Technical Shop will connect a portable load bank to load test the generator. No permanent load bank is required.
- For an indoor unit or an outdoor unit not in an accessible location on grade, provide a permanent, 100 percent rated, resistive load bank with integral control panel.
 - Specify the direction of heat discharge and show the direction on the drawings.
 - Provide a load dump circuit to immediately trip the load bank if a loss of normal power occurs during a load test. Show the control wiring on the drawings.
 - Provide a digital monitoring system with memory to display and log generator volts, amps, kW and frequency.

For units 1,000 kW and above, specify the most heavily loaded ATS as a soft-loading ATS. Only one ATS can be soft-loading. Usually the best choice is the required standby power ATS.

- Size the soft-loading ATS for at least 70 percent of generator full load. Size the ATS feeder cable from the generator, the ATS feeder cable from the unit substation, and the unit substation feeder breaker to match the ATS size. The generator shall be load tested to at least 70 percent by paralleling with and back-feeding through the unit substation.
- Provide shunt trip units on the unit substation and generator breakers that feed the soft-loading ATS. Provide conduits and control wires from the soft-loading ATS to trip the shunt trips.
- Calculate the voltage relay, current relay, time delay and soft-loading control settings of the ATSs in accordance with manufacturer's instructions. Provide the settings in table format to U-M for approval prior to ATS startup.
- When the elevators are supplied generator emergency or standby power, do not supply the elevators from the soft-loading ATS.

Automatic Transfer Switches

Specify the automatic transfer switches (ATSs) to be provided as part of the engine-generator package. Do not specify them separately.

- Provide 3 pole ATSs rather than 4 pole except where the generator neutral is grounded, the generator feeds multiple buildings, or 4 pole ATSs are required by code.
- Provide open transition ATSs to feed loads that can withstand interruptions and will restart automatically after transfer to and retransfer from the generator.
- Provide closed transition ATSs to feed loads including elevators that will need to reboot or will not restart automatically after retransfer from the generator.
- Provide a soft-loading ATS when required for periodic engine-generator load testing.
- Verify the ATSs are adequately rated for the full amount of fault current available. Add in the generator fault contribution if the ATSs are closed transition or soft-loading.
- ATSs shall include full manual bypass.

- One ATS shall include a programmable generator exerciser time clock.

Natural Gas Fuel System

Contact DTEEnergy and ascertain the range of natural gas pressure available at the outlet of the DTEEnergy regulator. Update Specification 16231 to specify this gas pressure range.

Size the gas piping system for negligible pressure drop at maximum gas flow. A frequent cause of generator problems is undersized gas piping.

Provide gas piping in accordance with NFPA 37, a gas regulator at the engine in compliance with the engine-generator manufacturer's recommendations, and a gas pressure gauge downstream of the gas regulator.

Obtain the approximate dimensions of the DTEEnergy gas meter train (often 12 feet or more in length) and locate the meter train where it won't detract from the building's appearance. Provide concrete-filled steel pipe bollards with yellow PVC jackets where appropriate to protect against vehicle impact.

Engine Exhaust System

Design the exhaust system in accordance with the results of the exhaust effluent study and in accordance with engine-generator manufacturers' instructions.

- Provide a flexible section to isolate the exhaust system from engine vibration.
- Calculate the exhaust system's expansion and contraction with temperature, and provide supports, slides and restraints as required.
- Direct the exhaust upward rather than horizontal, and away from buildings, trees, plants and anything else that is combustible.
- Provide a hinged, flapper style rain cap at the top of the exhaust stack. Do not provide a stack termination that deflects exhaust horizontally, including an inverted cone style cap.
- Provide a manual blowdown valve in a pipe tapped into the lowest point of the exhaust system, and pipe the discharge to a bucket on the floor.

Provide a silencer with 35 dBA minimum attenuation when the engine-generator is located in or near an occupied building. Provide a silencer with 25 dBA minimum attenuation when the engine-generator is located remote from occupied buildings. Provide a higher attenuation silencer when required by the results of the sound study.

A natural gas unit will require a 3-way catalytic converter. A diesel unit may require a catalytic converter or at least a particulate filter. Integrate the catalytic converter or particulate filter with the silencer if possible. Provide access for maintenance of the catalyst or filter.

Controls and Indications

Provide an NFPA 110 compliant control panel mounted on the engine-generator no more than 78 inches above the finished floor to the top of the panel, including the concrete housekeeping pad.

When the unit includes multiple accessories requiring power, provide a 208Y/120 volt, three phase load center panel to feed the battery charger, water jacket heater, and any electric lube oil pumps, motorized dampers, lights, and receptacles. Feed the panel with standby power.

Provide a guarded, remote manual stop station in accordance with NFPA 110. Locate it on the outside of the generator room or enclosure near the latch side of the door. Label it with a laminated plastic nameplate, white letters on a red background.

When the building is classified as a high rise building and it includes a Fire Command Center, provide a remote generator annunciator panel in the Fire Command Center. Otherwise, provide a remote annunciator panel in a location where it will be readily visible to maintenance personnel. The remote annunciator panel shall mirror all status indicators and alarms contained on the engine-generator control panel.

When the building contains a Fire Command Center, provide a generator remote “Auto-Run” switch and ATS status indicators in accordance with Design Guideline SBA-J.

Connect “generator running” and “generator trouble” output contacts to separate points in a Building Automation System (BAS) DDC panel. Show these DDC points on the drawings.

Connect in series an “on generator power” auxiliary contact in each ATS to a single point in a DDC panel to notify BAS if any ATS transfers to generator power. Show this DDC point on the drawings.

Do not connect any generator or ATS output contacts to MOSCAD or to the fire alarm system.

Do not use ATS auxiliary contacts to control mechanical systems because false mechanical system operation can occur during ATS testing and maintenance.

Generator Room Requirements

Separate the generator room from occupied areas or provide sound-proofing so engine-generator noise will have minimal impact on surrounding areas. Provide sound attenuation at intake and exhaust dampers when required by the results of the sound study.

Extend the walls from the floor to the deck above. CMU block walls are recommended for noise mitigation and safety. Where required by code, provide fire-resistance rated walls and doors.

Provide the NEC-required working spaces on all sides of each piece of electrical equipment. Provide the NEC-required dedicated equipment space above each piece of electrical equipment.

Provide a minimum of 2 exit doors on opposite ends of the room if the generator is rated 1200 amps or more.

- Exit doors shall swing outward from the room.
- Exit doors shall be equipped with panic bars. Double doors require only a single panic bar.
- One door shall be large enough for passage of the largest piece of the unit.

Provide a 4 inch minimum concrete housekeeping pad with chamfered edges under each piece of floor-mounted equipment. The engine-generator housekeeping pad shall be steel reinforced in accordance with the engine-generator manufacturer's instructions.

Provide 2 coats of water-borne epoxy paint over a compatible primer on the concrete floor.

Provide paint or a concrete sealer on concrete walls and ceilings.

Provide a 10 pound Type ABC fire extinguisher at each exit door.

Provide an unobstructed route to the building exterior to permit replacement of the engine or generator. Design the floor of the entire route for the weight of the heaviest piece of the unit.

Provide a route to move drums of oil and other large maintenance items to the generator room.

In below-grade generator rooms, provide a floor drain tight to a side wall.

- Provide a backwater check valve for the floor drain.
- Provide a water leak detector adjacent to the floor drain and tight to the wall so it isn't a trip hazard. Connect its alarm contact to a Building Automation System DDC panel, and show this DDC point on the drawings.

Provide a propylene glycol or dry pipe sprinkler system in accordance with Design Guideline 15300. A wet pipe sprinkler system shall not be used.

- Locate the sprinkler heads and route the piping over aisles, not over electrical equipment.
- Provide wire guards on the sprinkler heads.

Provide motorized dampers fed by generator power for combustion and cooling air in accordance with Design Guideline 15975 and engine-generator manufacturer's instructions.

- Size the dampers for less than 500 feet per minute air flow. Provide calculations to document compliance.
- Provide louvers exterior to the dampers when the dampers are visible to the public.

Provide generator power to the controls associated with combustion air, ventilation air and other systems that must operate when the engine-generator is operating. Provide generator power to any pumps providing fuel or cooling water to the engine-generator.

Provide unit heaters to maintain room temperature above 45 degrees F when the unit isn't running.

Provide grounding in accordance with Design Guideline 16450.

Provide manually-switched fluorescent lighting and connect it to an emergency power circuit. Provide a battery-backed emergency lighting fixture to light the engine-generator control panel.

Provide exit signs above the exit doors.

Provide a fire alarm system horn/strobe or speaker/strobe.

Provide duplex receptacles and connect them to standby power.

Outdoor Enclosure Requirements

Provide the engine-generator manufacturer's standard weather-protective, non-walk-in outdoor enclosure for most projects. When recommended by the results of the sound study or when the engine-generator is adjacent to an occupied building, provide an appropriately rated walk-in, sound-attenuating enclosure.

- Provide a floor unless the enclosure will be fastened down to a level concrete pad. Enclosures that are open on the bottom to air or grating are not acceptable.
- Provide clearance above the radiator cap to permit viewing down into the radiator without using a mirror, and to permit adding coolant without using a pump.
- Provide access and clearance around the engine and generator for routine maintenance.
- When providing a walk-in enclosure, provide manually-switched, cold weather starting fluorescent lighting and at least two duplex receptacles.

Installation Requirements

The engine-generator, automatic transfer switches, load bank, accessories and supporting systems shall be installed, adjusted and tested in accordance with Specification 263000 and the other Division 23 and 26 specifications.



LIGHTNING PROTECTION

General

Early in the design of a new building, if the building will be taller than surrounding buildings and structures, provide a Lightning Risk Analysis in accordance with Appendix L of NFPA 780. The Project Team will review the Risk Analysis and determine if a lightning protection system should be provided.

Related Sections

U-M Design Guideline Sections:

[260500 – Common Work Results for Electrical](#)

[260533 –Electrical Materials and Methods](#)

[260526 – Grounding and Bonding for Electrical](#)

[260800 – Electrical Acceptance Tests](#)

Reference Documents:

NFPA 70, “National Electrical Code”

NFPA 780, “Installation of Lightning Protection Systems”

UL 96A, “Installation Requirements for Lightning Protection Systems”

Lightning Protection System Requirements

If it is determined that a lightning protection system should be provided, provide a traditional type of system in accordance with the appropriate chapter of NFPA 780. Do not provide an early streamer emission system or a charge dissipation system.

Provide UL listed or labeled lightning protection components and cables. Provide copper or bronze components and cables. Aluminum components and cables are not acceptable.

Ground the lightning protection system using separate copper-clad ground rods in accordance with Design Guideline 16450. The building ground system rods shall not be used. Do not provide chemically enhanced ground rods or ground test wells.

Obtain an electrical inspection of the underground components before burying them.

Test the lightning protection system in accordance with Design Guideline 16950. After both the lightning protection system and the building ground system have been completed and tested, bond the two systems together. Obtain a final electrical inspection.

The lightning protection system shall be installed by an Underwriters Laboratories Master Label Installer in accordance with UL 96A. After the system is completed and tested, the Installer shall provide a UL Master Label suitable for mounting in the building’s unit substation room.



INTERIOR LIGHTING

Scope

This Design Guideline applies to building interior lighting. Refer to Design Guidelines SBA-A and SBA-E for additional interior lighting requirements related to animal facilities and parking structures. Refer to Design Guideline 16521 for requirements related to outdoor lighting.

Related Sections

U-M Design Guideline Sections:

[SBA-A - Animal Facilities](#)

[SBA-E - Parking Structures](#)

[SID-D - Energy and Water Conservation](#)

[265600 - Exterior Lighting](#)

[Electrical Trades Preferred Manufacturers List](#)

U-M Master Specification Sections:

[260500 - Basic Electrical Requirements](#)

[265100 - Interior Lighting](#)

U-M Standard Details:

[260000 Series - Electrical Standard Details](#)

Reference Documents:

ASHRAE 90.1-2007, "Energy Standard for Buildings Except Low-Rise Residential Buildings"

IES HB-10-2011, "Lighting Handbook"

State of Michigan Building Code

State of Michigan Elevator Code

Design Requirements

Use U-M Master Specification 16511 "Interior Lighting" to specify interior lighting on all projects. Use the appropriate U-M 16500 Series Standard Details. Edit the specification and details to make them project specific. When editing the specification, turn on hidden text and follow the Spec Editor notes.

Promote the use of skylights, clerestory windows, light shelves and other architectural features to channel non-glaring natural daylight into the building.

Promote the use of light colored finishes on ceilings, walls and floors to increase light reflectivity and reduce the need for artificial ambient light.

Promote the use of under-shelf and table lamp task lights on laboratory benches, office desks, study tables and other work surfaces to further reduce the need for artificial ambient light.

Normal Lighting Requirements

Except when special codes (hospital, food service, NIH, etc.) take precedence, provide normal lighting levels as follows. Provide lighting calculations to demonstrate compliance.

- Design light levels in accordance with the IES Lighting Handbook. Design for the full range of occupant ages, the tasks being performed and the associated need for contrast.
- Design lighting so the ratio of light levels between adjacent spaces does not exceed 10:1.
- Provide a normal lighting level at floor level along the means of egress (including the exit discharge) of 1 footcandle (fc) minimum at all time the building is occupied.
- In auditoriums, lecture halls, classrooms, conference rooms, libraries and laboratories, the normal light level should be capable of being reduced during performances, demonstrations or video presentations to not less than 0.2 fc.
- The project's interior lighting power allowance shall not exceed the interior lighting power allowances listed in ASHRAE 90.1.
- When required by Design Guideline SID-D, the project's interior lighting power allowances should contribute toward a building's total annual energy cost savings at least 30 percent below an ASHRAE 90.1 baseline building.

Do not provide continuously illuminated "night lighting".

Provide fluorescent lighting for most applications.

- LED lighting may be used for emergency lighting, task lighting, highlighting, aisle lighting and decorative lighting. It may be used for ambient lighting when an energy cost savings analysis justifies its higher initial cost.
- Retrofit fluorescent fixtures with LED retrofit lamps only when an energy cost savings analysis justifies the high cost of LED lamps.
- Metal halide and induction lighting may be used for high ceiling applications.
- Avoid incandescent lighting due to its low efficiency and short lamp life.
- Avoid fiber optic lighting due to its very low efficiency and very high maintenance.

Provide vertical illumination across the full length and height of chalk and marker boards, and on library shelves, wall-mounted art and signage, and other vertical surfaces requiring illumination.

Consider indirect lighting to minimize glare, especially in areas with computer monitors.

Avoid locating downlights above shiny floors and stairs where reflected glare may cause falls.

Locate fixtures and remote ballasts so they are accessible for maintenance by the use of a ladder only, or provide fixtures equipped with a lowering device. Obtain Design Manager approval before locating fixtures or remote ballasts where a lift or scaffolding is required for maintenance.

Locate wall fixtures sufficiently below ceilings and provide cove fixtures with adequate access openings so lamps and ballasts can be replaced without removing fixtures or cutting coves.

Locate ceiling mounted fixtures so their lenses can be removed and their components can be replaced without removing adjacent mechanical or electrical equipment.

Emergency Lighting Requirements

In the event of a power supply failure, provide an emergency lighting level at floor level along the means of egress (including the exit discharge) of 1 fc average and 0.1 fc minimum.

- The exit discharge typically includes exterior landings, stairs and ramps leading to the public way.
- Provide lighting calculations on a 2 foot by 2 foot grid to demonstrate compliance.
- In a high rise building, ignore Michigan Building Code Paragraph 403.5.5 which requires luminous egress path markings. This code paragraph was published in error.

Connect an appropriate number of normal lighting fixtures to generator-backed emergency lighting circuits whenever generator emergency power is available. If generator emergency power is not available, provide emergency lighting battery pack units.

- Do not locate emergency lighting battery pack units outdoors or in unheated spaces.
- In finished spaces, backing up normal lighting fixtures with battery pack units is preferred to providing sealed beam wall pack emergency lighting units.
- Central battery-inverter systems are strongly discouraged and may be used only with Design Manager approval.

In addition, provide sealed beam wall pack emergency lighting units in the following rooms even when generator-backed emergency lighting is provided:

- Unit substation and emergency generator rooms.
- Elevator machine rooms, elevator control rooms, and on MRL elevator machines.
- Mechanical rooms containing boilers, chillers, fans, pumps or compressors.

Emergency lighting battery packs and sealed beam emergency lighting units should include self-diagnostic and self-exercising circuitry to exercise and test themselves for 5 minutes every month and for 30 minutes every 6 months. Provide units with LED status indicating lights visible to the public. Do not provide units containing audible alarms.

When providing HID lighting fixtures for normal lighting, specify quartz restrike lamps in some of the fixtures or provide some fluorescent fixtures for light immediately after a power outage.

Lighting in Elevator-Related Spaces

Provide elevator space lighting in accordance with the Michigan Elevator Code and as follows whenever the elevators have the ability to run. Strict compliance is mandatory to obtain an elevator permit.

- Elevator lobbies - 10 fc minimum at elevator door sills at floor level with the elevator doors closed.
- Elevator machine rooms and control rooms - 19 fc minimum at floor level everywhere.
- Spaces containing elevator machinery (MRL elevator machines, remote sheaves, etc.) - 19 fc minimum on the equipment.
- Elevator pits - 10 fc minimum at floor level everywhere.
- When the elevators are capable of operating on generator standby power, connect all elevator space lighting to generator emergency power.
- When the elevators are not capable of operating on generator standby power, connect elevator space lighting to generator emergency power anyway if emergency power is available. If generator emergency power is not available, provide 1 fc average and 0.1 fc minimum of battery-backed emergency lighting in elevator spaces.
- Several U-M departments require and will pay separately for vertical-mounted, metal guarded, fluorescent strip lights the full height of each elevator shaft. Coordinate with the Design Manager to determine if elevator shaft lighting is required on your project. If required, control the shaft lighting from 3 locations including the machine or control room, the top landing and the elevator pit.

Lighting Fixture Requirements

Except in University Housing facilities, provide lighting fixtures rated for operation at 277 volts wherever possible. In Housing facilities, provide 120 volt fixtures.

Lighting fixtures in Housing facilities shall be abuse resistant, especially in student rooms and corridors.

Lighting fixtures shall be listed and labeled by Underwriters Laboratories (UL) or other approved Nationally Recognized Testing Laboratory (NRTL). Provide fixture types known to have been used with success elsewhere. Do not specify newly developed or unproven fixtures.

Specify lighting fixtures from manufacturers in the Electrical Preferred Manufacturers List (PML). When necessary to meet special architectural or photometric requirements, request Design Manager approval before specifying fixtures from other manufacturers. Demonstrate to the Design Manager that the proposed fixtures are available from a local supplier known by U-M for good quality products and service. Demonstrate that replacement parts are readily available.

To obtain competitive pricing, specify a minimum of three manufacturers for each fixture type. To reduce pricing, specify fixtures from local suppliers who can package multiple fixture types.

Specify top covers for pendant bowl and wall sconce fixtures to keep trash and bugs out.

Specify recessed fixtures whose components can be replaced through the fixture apertures unless the ceiling is accessible or a catwalk exists above the ceiling.

Specify recessed compact fluorescent fixtures without lenses.

Lamp Requirements

In general, linear fluorescent lamps shall be 4' maximum, T8, with a color temperature of 3500 degrees K and a Color Rendering Index (CRI) of 85 minimum. High output T5 fluorescent lamps matching the T-8 lamps in color temperature and CRI may be used only when necessary to meet special fixture or photometric requirements. U-tube and normal output T5 fluorescent lamps shall not be used. See Master Specification 16511 for more requirements.

Compact fluorescent lamps shall have a color temperature of 3500 degrees K, a CRI of 80 minimum, and be suitable for use with electronic ballasts. Specify self-ballasted compact fluorescent lamps only for retrofitting existing incandescent fixtures on non-dimming circuits.

High Intensity Discharge (H.I.D.) lamps shall conform to the applicable ANSI codes.

Light Emitting Diode (LED) and induction lamps shall have a color temperature close to 3500 degrees K. LED lamps shall have their LEDs wired in parallel to prevent multiple LED failures.

Halogen MR-16 lamps are prohibited. LED MR-16 lamps may be used.

Request Design Manager approval before specifying lamp technologies other than those listed above. Demonstrate to the Design Manager that the proposed lamp technologies provide unique advantages to the project.

Lamps in a single room or area shall appear close in color temperature.

Lamps shall be of low mercury content and designed to pass the Federal Toxic Characteristic Leaching Procedure (TCLP) test for classification as non-hazardous waste.

Ballast and Driver Requirements

Ballasts for T8 and high output T5 fluorescent lamps shall be NEMA Premium or 90 percent efficient minimum, electronic type, programmed rapid start, parallel circuited, and rated for a minimum start temperature of 0 degrees Fahrenheit. Ballasts shall be of the single, two, three, or four-lamp type as appropriate for the switching scheme, and shall only serve one fixture.

Ballasts for compact fluorescent lamps shall be 90 percent efficient minimum, electronic type, and shall have built-in End of Life (EOL) protection.

Ballasts for H.I.D. fixtures in finished spaces shall be electronic or shall be mounted remotely so ballast noise is not objectionable.

Drivers for LED and induction fixtures shall be electronic and shall not heat to a temperature exceeding 140 degrees F.

Avoid dimmable ballasts that require separate control wiring. If separate control wiring is required, clearly show this on the plan drawings. Route it in the same conduit as the power wiring when allowed by code and the manufacturer.

Ballasts and drivers shall be rated for the extremes of ambient temperature in which they are located. Specify ballasts and drivers rated for reliable starting to minus 20 degrees F for fixtures mounted in unheated spaces. Specify high ambient temperature ballasts and drivers for fixtures mounted indoors in direct sunlight or in high ambient temperatures spaces.

Exit Sign Requirements

Provide exit signs to meet code egress requirements, in rooms where code requires two or more exit doors and in rooms designed for 50 occupants or more. In addition, provide exit signs in unit substation rooms, engine-generators rooms and large mechanical rooms.

Exit signs shall be on at all times and shall be LED illuminated. Radioactive, self-luminous and photoluminescent exit signs of any type shall not be used.

Exit signs shall have die cast aluminum or polycarbonate housings with universal mounting brackets, brushed aluminum stencil faces, red letters and red directional arrows.

- Provide green letters and arrows only in buildings where existing exit signs have green faces.
- Provide internal emergency battery packs and battery chargers when generator emergency power is not available.
- Provide abuse resistant exit signs in University Housing facilities and parking structures.

Lighting Control Requirements

Lighting controls shall be simple and intuitive to use, including for visitors unfamiliar with the space.

Provide clear, concise signage with ¼ inch high letters adjacent to controls for multiple scene lighting.

Where light levels in auditoriums, lecture halls, classrooms, conference rooms, libraries and laboratories are capable of being reduced during special events, provide controls to automatically turn on the emergency lights if normal power fails or if the fire alarm system activates.

Control each room and each block of open office space separately and locally. Lights shall not be controlled from panel circuit breakers.

Provide occupancy sensors (OSs) in most rooms and spaces to control the lighting. OSs generally save more energy than timeclocks.

- OSs may be passive infrared, ultrasonic or dual technology (infrared combined with ultrasonic or microphonic).
 - Infrared/microphonic OSs are preferred to ultrasonic and to infrared/ultrasonic OSs because ultrasonic and infrared/ultrasonic OSs are susceptible to nuisance activations from ventilation air currents.
 - Ultrasonic and infrared/ultrasonic OSs shall operate at 40 kHz minimum to avoid interfering with hearing aids.
 - OSs shall operate without producing an audible clicking noise during switching.
- Show the OS locations on the reflected ceiling or lighting plan drawings. Do not make the Contractor responsible for determining OS locations.
 - Follow manufacturer's spacing instructions to achieve total space coverage.
 - Indicate the manufacturer's recommended separation from air diffusers, return air grilles and other building features which can affect proper OS operation.
- OSs shall be powered by the lighting circuit. Battery powered OSs shall not be used.
- OSs in public spaces including auditoriums, lecture halls, classrooms, conference rooms, libraries, laboratories, corridors, stairwells, lobbies, and toilet rooms shall be automatic "on" and automatic "off". In auditoriums, lecture halls, classrooms, conference rooms, libraries and laboratories, provide manual "on" and "off" override switches.
- OSs in private spaces such as offices and janitors closets shall be manual "on" and automatic "off". Provide manual "on" and "off" override switches.
- When OSs control emergency lights, the OSs shall be equipped for "fail on" operation and their illumination timers shall be set for an "on" duration of 15 minutes.
- Provide manual switches in lieu of OSs in unit substation, electrical, mechanical and telecommunications rooms. Provide manual switches in lieu of OSs in laboratories only where an unexpected shut-off of the lights could pose a safety risk.
- Provide multi-contact OSs to control both the lighting and the ventilation when required as an Energy Conservation Measure (ECM) in accordance with Design Guideline SID-D.
 - Use the lighting OSs to reduce the room ventilation, turn the ventilation off or widen the thermostat dead band during unoccupied periods.
 - When an area has multiple ventilation zones, provide separate OSs for each ventilation zone to control both the lighting and the ventilation in that zone.
 - Wire the OSs ahead of the manual "off" override switches so the lights can be turned off but the ventilation will remain on while the space is occupied.
- Consider providing OSs with integral daylighting sensors to block turning on the lights when the incoming daylight is high.

When Occupants request dual level switching to control 3 and 4 lamp fluorescent fixtures, provide 2 switches and switch the outside and inside lamps separately. As an alternative to dual switching, provide multi-lamp dimming. Do not provide device-addressable lighting controls or a BACNet interface between the lighting controls and the HVAC controls at this time. These technologies are not sufficiently developed yet, and their additional installation and programming costs far exceed their energy cost savings.

When OSs turn off the emergency lights during unoccupied hours, provide controls to automatically turn on the emergency lights if normal power fails or if the fire alarm system activates..

In rooms with large windows, orient fixtures in rows parallel to the windows. Provide daylighting controls to dim the fixtures near windows when the incoming daylight is high.

Provide photocell controls to control fixtures in skylights or atrium ceilings to turn off the fixtures when the amount of incoming natural daylight is sufficiently high.

Lamp and Ballast Recycling

Fluorescent lamps and ballasts being demolished or replaced shall be recycled in accordance with the University recycling policy contained in Specification 16010.

Installation Requirements

Lighting fixtures, controls, accessories, conduits and wiring shall be installed, adjusted and tested in accordance with Specification 16511 and the other Division 1 specifications.



EXTERIOR LIGHTING

Scope

The overall goal of the outdoor lighting (street, parking lot, pedestrian and building exterior lighting) is to improve and enhance the sense of safety and security in an efficient and sensitive manner. The lighting design shall take into consideration horizontal and vertical luminance and the uniformity of the distribution of light while minimizing glare, light pollution and light trespass. In addition, the lighting design should impart a sense of order, contribute to the overall campus aesthetic and ambience, enhance wayfinding, and strengthen U-M identity.

Related Sections

U-M Design Guideline Sections:

[260500 – Common Work Results for Electrical](#)
[260533 - Electrical Materials and Methods](#)
[260543 - Underground Services for Electrical Systems](#)
[260513 – Medium, Low & Control Voltage Cables](#)
[265100 – Interior Lighting](#)
[260800 – Electrical Acceptance Tests](#)

U-M Master Specification Sections:

[265600 – Exterior Lighting](#)
[329210 - Lawn Repair](#)

U-M Standard Details:

[260000 Series - Lighting Details](#)

References

ASHRAE 90.1, "Energy Standard"
IESNA, "Lighting Handbook"
MBC, "Michigan Building Code"
NFPA 70, "National Electrical Code"
NFPA 101, "Life Safety Code"
USGBC, "LEED Rating Systems"

Design Process

This Design Guideline standardizes U-M outdoor lighting equipment and installation methods to strengthen U-M identity and to enhance lighting reliability and maintainability. However, it is not intended to limit creativity or innovation. Newer technologies and improved products will be considered, but must be submitted for approval before being used. Significant deviations from this Design Guideline may require Regental approval.

As a Design Deliverable at the end of Schematic Design, submit a preliminary site lighting plan showing the proposed outdoor lighting locations and general equipment types.

As a Design Deliverable at the end of Design Development, submit the following electronic files of plans, simulations, equipment descriptions and photometrics for U-M mock-up and approval:

- Lighting plans showing dimensioned equipment locations and luminaire type designations.
- Lighting simulations showing calculated results, including:
 - Name and version of simulation software used.
 - List of assumptions (if any).
 - Summary results for each area (maximum, minimum, average, avg./max, avg./min, etc.).
 - Average maintained horizontal illuminance on grade, shown in a grid pattern, in footcandles or lux.
 - Average maintained vertical illuminance at 5 feet/6 inches above grade in at least two directions of main travel, in footcandles or lux.
- Lighting equipment specifications and manufacturer cut sheets, including:
 - Luminaire types, descriptions, dimensions, optics, materials, and finishes with IESNA formatted photometric data files.
 - Pole and/or mounting support descriptions, dimensions, materials and finishes.
 - Lamp type for each luminaire, and lamp wattage, color temperature, color rendering index, and related life.

Design Requirements

Facilitate facial recognition through vertical illumination and careful selection of the color temperature and color rendering of the light sources.

Control light distribution to prevent direct glare to motorists, pedestrians and occupants of adjacent buildings, light pollution, and light intrusion onto adjacent private property.

Compensate for existing or planned light obstacles such as buildings and fully leafed trees.

Locate lights to emphasize specific building components and site features (i.e. building entrances, fenestration patterns, columns, pedestrian/vehicular nodes or gateways). Locate lights symmetrically at building entrances. Alternate lights on both sides of long, straight sidewalks.

Locate lights to frame important campus views and to avoid competing with existing illuminated and non-illuminated campus elements.

Locate lights on U-M property. Avoid locating lights in City right-of-way or on private property. Coordinate with the Design Manager to obtain City approval of lighting in City right-of-way.

Locate building-mounted lights 12 feet minimum above grade. Lighted bollards, hand rail lights, in-wall lights, step lights and in-ground lights are discouraged. Underwater pool and fountain lights are not allowed.

Locate lights outside the drip lines or root zones of significant (in size or age) vegetation. Request that U-M clear any significant vegetation if required.

Avoid lighting sporting and picnicking areas near Housing facilities because this encourages their use late at night.

Provide emergency power to building exterior lighting at exits when necessary to meet MBC and Life Safety Code requirements for emergency lighting at exterior exit discharges.

Provide a 100 watt quartz restrike lamp in the light nearest to each emergency telephone kiosk and bus shelter.

Provide light levels in accordance with IESNA recommendations, which are summarized for most applications in the following table.

AREA DESIGNATION	CRITERIA	ATTRIBUTE	TARGET
Pedestrian ways distant from roadway	Horizontal illuminance	Average maintained illuminance on pavement	0.5 footcandle
		Average-to-minimum uniformity	5:1
	Vertical illuminance	Average maintained illuminance at 5-feet/6-inches above grade in at least two directions (in direction of main travel)	0.5 footcandle
		Average-to-minimum uniformity	5:1
Pedestrian ways adjacent to roadways	Horizontal illuminance	Average maintained illuminance on pavement	0.5 footcandle
		Average-to-minimum uniformity	5:1
	Vertical illuminance	Average maintained illuminance at 5-feet/6-inches above grade in at least two directions (in direction of main travel)	1.0 footcandle
		Average-to-minimum uniformity	5:1

Parking lots	Horizontal illuminance	Minimum maintained illuminance on pavement	0.6 footcandle
		Average-to-minimum uniformity	4:1
Roadways	Horizontal illuminance	Average maintained illuminance on pavement	0.9 footcandle
		Average-to-minimum uniformity	4:1

Feed street, parking lot and pedestrian lights at 277 volts from a 480Y/277 volt, 3 phase, 4 wire circuit. Feed them with four No. 4 AWG conductors plus a No. 8 AWG ground conductor in a 1-1/4 inch, Schedule 40 PVC or HDPE conduit. Alternate feeder circuit phases for each successive light so that a single phase failure will not leave large areas in total darkness. Balance the load across all three phases, and limit the total load to 29 kVA. Before adding lights to an existing circuit, request that U-M provide the existing load on the circuit.

Provide a dedicated circuit for emergency telephone kiosks, illuminated signs, parking lot electric gates and Parkmasters. Feed them at 120 volts single phase with No. 10 AWG conductors plus a No. 10 AWG ground conductor in a 1 inch, Schedule 40 PVC or HDPE conduit.

Control street, parking lot, pedestrian, and building exterior lighting with lighting contactors. Lighting contactors shall be switched by a Building Automation System (BAS) Direct Digital Control (DDC) panel contact. Provide local photocell control only if BAS control is not available. Do not provide a time clock or an individual photocell in each light. Wire the control circuit so that the lighting will be energized in the event of a BAS System or photocell failure.

Products

Street and Parking Lot Lighting

In general, provide the U-M standard low profile, full cutoff, rectangular, black, aluminum shoebox fixtures with 250 watt metal halide lamps on 30 foot, round, tapered, black, aluminum poles. Lamp wattage and pole height may be reduced when necessary to minimize light trespass on surrounding areas. On the top deck of parking structures, the poles shall be hinged at the bottom so the fixtures can be maintained without the use of a bucket truck. Copy verbatim the appropriate requirements of Master Specification 16521 and Standard Detail 16500029 when specifying this equipment.

Pedestrian Lighting

Provide the U-M standard 16 inch, round globe fixtures with 6 spoke, black globe baskets, mounted singly, in doubles, or in fives on round, tapered, black, aluminum poles. Provide metal halide lamps, typically 100 watts in single globe fixtures, 70 watts in double globe

fixtures, and 50 watts in five globe fixtures. As an alternative to mounting the fixtures on poles, mount them on column tops or with wall brackets. Specify pole lengths and mounting brackets to locate the horizontal center bands of the globe baskets at 12 feet, 0 inches above grade. Copy verbatim the appropriate requirements of Master Specification 16521 and Standard Detail 16500019 when specifying this equipment.

Installation Materials

Copy verbatim the appropriate requirements of Master Specification 16521 when specifying pole base materials, conduits, sleeves, wire, terminations, fuse holders, fuses, etc.

Lighting Contactors

Lighting contactors for outdoor lighting shall be NEMA 1, 3-pole, 4-wire, 480 volt, 60 amp, combination fused switch contactors with 50 amp fuses. They shall be electrically held, and include a hand-off-auto switch and a 300VA, 277:120V control power transformer. Specify that the outdoor lighting contactors will be furnished by the U-M Utilities Power and Lighting Shop (734.647.7049).

Execution

Pole Bases and Underground Work

Specify that Miss Dig (800.482.7171) be contacted before performing excavation work.

When existing lighting is being demolished, specify the following:

- Power shall be maintained to lighting on the same circuits but outside of the work area.
- Demolished lighting fixtures and poles shall be turned over to the U-M Utilities Power and Lighting Shop.
- Existing pole bases shall be removed completely and holes left by the pole bases shall be backfilled and restored. Holes in lawn areas shall be re-seeded.
- Temporary lighting shall be provided at the same lighting level as the demolished lighting until the demolished lighting is replaced. As an alternative, construction fencing shall be provided to prevent public access until the demolished lighting is replaced.

Pole bases shall be located and constructed in accordance with Master Specification 16521 and the appropriate Standard Details. Bases should not be located in sidewalks. They should be located to minimize impact on snow removal and lawn mowing, and where they will not be damaged by maintenance equipment.

Stub out a spare 1-1/4 inch conduit from every fourth or fifth pole base, and especially at corners and intersections, for expansion of the lighting circuit in the future. Select pole bases

with only one or two active conduits. Aim spare conduits toward open lawn areas for easy access later.

Provide a 5/8 inch diameter x 8 foot long copper clad ground rod for each light pole base, and connect it to the pole ground lug. See the Standard Details.

Specify Schedule 40 PVC or HDPE conduits to feed in-wall and in-ground lights. Develop a detail showing the conduits entering the lights only from below.

Avoid locating in-ground junction boxes in sidewalks or driveways. Hide them in landscaping whenever possible.

Design underground conduit runs parallel to parking lot edges, sidewalks, and driveways, and adjacent to the pavement edges, to avoid interfering with future landscaping or other excavations.

When streets, parking lots, or sidewalks are cut for the installation of any underground utilities, provide a 6 inch sleeve for future outdoor lighting circuits. See the Standard Details.

Quality Assurance

Specify that the Contractor contact the U-M Code Inspection Department (734.764.2457) before pouring concrete, backfilling excavations, and energizing circuits.

Record Drawings

Specify that electronic files of record drawings or scanned mark-ups be provided at Substantial Completion for forwarding to the U-M Utilities Power and Lighting Shop. Record drawings shall show the actual locations of lighting poles, stubbed-out spare conduits, underground sleeves, and junction boxes, the circuit numbers for all circuits, and deviations from the design. Underground sleeve ends and junction boxes shall be dimensioned from permanent building or landscape features.



VOICE AND DATA COMMUNICATIONS

Related Sections

U-M Design Guideline Sections:

[SBA-C - Telecommunication Rooms](#)

[260500 – Common Work Results for Electrical](#)

[260526 – Grounding and Bonding for Electrical](#)

[260533 –Electrical Materials and Methods](#)

[260543 - Underground services for Electrical Systems](#)

U-M Master Specification Sections:

[260533 –Electrical Materials and Methods](#)

[260543 - Underground services for Electrical Systems](#)

[272000 - Voice and Data Communications](#)

U-M Standard Details:

[260000 Series - Electrical Standard Details](#)

Reference Documents:

ANSI/TIA/EIA-568-B, "Commercial Building Telecommunications Cabling Standard"

ANSI/TIA/EIA-569-A, "Commercial Building Standard for Telecommunication Pathways and Spaces"

ANSI/TIA/EIA-607, "Grounding and Bonding Requirements for Telecommunications in Commercial Buildings"

Design Requirements

Provide Building Entrance (BE) rooms, Telecommunication Rooms (TRs), telecommunication cable pathways, Work Area Outlets and incidentals as described below and in accordance with the Program Documents. Coordinate the telecommunications system design with the Design Manager. Copy the related Master Specification Sections and appropriate Standard Details into the design documents, and edit them to make them project specific.

Telecommunications systems in most U-M Ann Arbor Campus buildings are operated and maintained by the U-M ITSComm Department. In addition, ITSComm is usually involved with the telecommunications systems in U-M Health System buildings, on the U-M Dearborn and Flint Campuses, and at off-campus and leased facilities. This Guideline provides requirements for most University owned or operated buildings, even if the “serving utility” is not ITSComm.

System Description

The BE room is the main termination point in a building. TRs are distribution and termination rooms located on each floor of a building and serve Work Area Outlets within 293 cable feet (including 6 feet of slack at the TR room and 3 feet at the Work Area Outlet). If cable lengths will exceed 293 feet, provide additional TRs. The BE may also be the TR for that floor. Stack the BE and TRs wherever possible. The BE is connected to TRs via backbone cables in conduits. The BE is connected to equipment external to the building via service entrance cables in duct banks and outside plant cables in direct buried conduits. See Design Guideline SBA-C for additional architectural, mechanical and electrical requirements related to the BE and TRs.

ITSComm generally provides the network equipment, cabling and terminations from their network backbone to the Work Area Outlets, including the faceplates and telephone instruments at the outlets. Provide ITSComm with AutoCAD files of the completed CD phase telecommunication plan drawings. ITSComm will add numbers to the Work Area Outlets and cabling information to the drawings for their use in providing the cabling and terminations.

The current cable plant provides multiple 4-pair cables of copper conductors from each Work Area Outlet to the nearest BE or TR. These cables are used for all voice, telephone set power, and data services, including point-to-point and local area networking. Separate RG-6 coaxial cables are installed to locations noted for closed circuit TV and/or cable TV.

All Work Area Outlet (station) wiring will be home run from the Work Area Outlet to the nearest TR. For transmission integrity, no intermediate splices or terminals will be allowed. During renovations, if the existing cables will be too short, modify the existing cable pathways as necessary so new cables can be installed.

Telecommunication Service Entrance and Outside Plant Cabling

Consult with the Design Manager and ITSComm prior to proceeding with the telecommunication service entrance design.

Duct Banks, Manholes, Hand Holes and Underground Conduits

Provide a minimum of four 4-inch service entrance conduits in a concrete-encased duct bank extending from a location specified by ITSComm (typically a telecommunication manhole) to the building. Slope duct banks downward toward manholes and away from the building a minimum of 6 inches per 100 feet. Duct banks shall not route water from manholes into the building or contain traps between manholes where water may accumulate.

Encase service entrance conduits in concrete except where they terminate at poles. When terminating at a pole, clamp the conduits rigidly to the pole at a 90-degree separation from power conduits clamped to the pole.

Provide 12 foot by 6 foot by 7 foot high (inside dimensions) telecommunication manholes unless smaller manholes are approved by ITSComm.

Provide 1-1/2 inch minimum direct-buried conduits for outside plant cables serving emergency telephone kiosks, digital signs, parking controls and similar outdoor equipment.

Underground conduits shall not include more than 180 degrees of total bends or exceed 400 feet in length between pull points (manholes or hand holes), and shall have a bending radius of at least 10 times the conduit diameter. Provide manholes or hand holes in straight sections of conduit runs when necessary to meet these requirements. Hand holes shall not be used in place of conduit sweeps for directional changes in underground conduits. Conduit bodies, specifically LB fittings, are not allowed anywhere. Provide a nylon pull string in each conduit.

Provide a 6 inch wide red marker strip in the trench 1 foot above the duct bank or direct buried conduit.

In multi-utility trenches, the minimum spaces between telecommunication conduits or cabling and other facilities are: 3 inches where separated by concrete, 4 inches where separated by masonry, and 12 inches where separated by well-tamped earth.

Where conduits enter a building, extend the conduits 6 inches beyond the interior wall or floor. Plug spare conduits with water-tight mechanical seals.

If the termination point (typically the BE) of the building service entrance or outside plant cables is more than 50 feet inside the building, or if the cables run through plenum spaces, install the cables in galvanized steel rigid metal conduits. As an alternative and only when approved by ITSComm, provide a 4 foot by 4 foot minimum backboard where the cables entering the building can be spliced to cables rated for indoor use. Provide the NEC-required working space in front of the backboard. Piping and ductwork shall not be routed above the backboard.

Direct Buried Service Entrance Cables

Direct-buried service entrance cables are typically allowed only at off-campus and leased facilities, and only when specifically noted in the Program Documents. Consult with ITSComm prior to proceeding with direct-buried service entrance designs.

Inside Plant Cabling

Telecommunication Cable Pathways

Provide a continuous cable pathway between each Work Area Outlet and the nearest TR to support and protect the station cables. Acceptable cable pathways in order of preference are conduits, cable trays, J-hooks, wireways and underfloor duct systems. Cable pathways shall be continuous and unobstructed, accessible for maintenance and installation of additional cables with minimal disruption to building occupants, and located at a safe working height. Cable pathways serving multiple outlets shall include spare capacity for future use.

Conduits

Provide a conduit from each Work Area Outlet to the nearest TR or cable tray, or as a minimum to above the ceiling. Size conduits for a maximum of 40 percent fill. Minimum conduit size to an outlet box shall be 1 inch, except conduits to wall telephone outlet boxes may be 3/4 inch minimum. Alternate larger conduit sizes will be noted in the Program Documents.

Daisy chaining of outlet boxes is unacceptable, but up to three outlet boxes may be served from one NEC-sized junction box. Size the conduit feeding the junction box as follows:

- 1-1/4 inches for serving two outlet boxes.
- 1-1/2 inches for serving three outlet boxes.

Provide a 1-1/4 inch conduit for serving up to three 1-gang outlets in a surface raceway. Provide multiple 1-1/4 inch conduits to surface raceways containing high outlet densities.

Design conduit runs for minimal bends and as short a path as possible. Provide pull boxes sized in accordance with the NEC in straight sections of conduit every 100 feet or 180 degrees of total bends. For conduits over 2 inches in diameter, consult ITSComm on pull box size. Bends in conduits over 2 inches shall be long sweeps, and no conduit shall have a bend radius less than 10 times the conduit diameter. Conduit bodies, specifically LB fittings, are not allowed.

Conduits shall not be routed within 12 inches above or 4 inches horizontal from hot equipment and pipes, including boilers, water heaters, incinerators, hot water heating lines and steam lines, or through areas in which flammable or other hazardous material may be stored.

Terminate horizontal conduits entering a BE or TR 6 inches inside the room. Extend conduit floor sleeves 6 inches minimum above the floor. Terminate conduits with nylon insulated grounding bushings. Provide a nylon pull string in each conduit.

Fire seal between recessed outlet boxes located on opposite sides of a fire rated wall if the boxes are less than 24 inches apart.

After cables are installed, seal floor sleeves and wall penetrations in fire-rated walls using listed fire-sealing systems.

Cable Trays

Telecommunication cable trays shall be of the aluminum ladder type, or galvanized or zinc electroplated steel wire basket type. Aluminum center spline cable trays may be used only where approved by ITSComm, and only when supported so rigidly they do not tilt if unevenly loaded.

Size cable trays based upon the square footage of the area being served, the number of Work Area Outlets planned for the space, and the diameter of the cables as follows:

- If Work Area Outlet locations are not yet known, assume a minimum of one outlet for every 100 square feet of useable floor space served by the cable tray.
- Standard Work Area Outlets are served with three 4-pair cables with an average cable diameter of 0.165 inch each.
- Provide a minimum of 50 percent spare cable capacity for future use.
- The maximum allowable cable tray fill shall not exceed 50 percent of the tray cross-sectional area.

Design cable tray installations as follows:

- Provide 12 inches minimum access above and 18 inches minimum access on one side of cable trays for ease of cable pulling.
- Locate cable trays so they can be accessed safely from a ladder, taking into consideration access restrictions including ducts, pipes, conduits, light fixtures and ceiling grids.
- Ducts, pipes, conduits, light fixtures, ceiling grid support wires or other mechanical or electrical items shall not be attached to, pass through, or located within the cross-sectional area of cable trays.
- Cable trays shall not be used in place of conduit runs specified for computer room tie cables or other riser type cable installation.

Terminate cable trays entering a BE or TR 6 inches inside the room. Provide barriers in cable trays when necessary to separate circuits of different low voltage levels.

J-Hooks

Telecommunication cables may be installed in J-hooks above accessible ceilings in rooms, but J-hooks shall not be installed in corridors. Provide conduits or cable trays in corridors because the high quantity of cables will result in cable damage if the cables are installed in J-hooks.

Cables may be installed in J-hooks in unfinished open ceiling areas, but only if a minimum of 10 feet AFF, only if the cables will be protected from damage, and only if the cables are completely accessible for replacement. Cables shall not be installed in J-hooks in finished open ceiling areas or above inaccessible ceilings.

If cables in J-hooks penetrate a corridor wall from a room, and the distance from the wall to the cable tray is more than 18 inches, provide conduit stubs from the wall to the cable tray.

J-hooks for telecommunication cables shall be zinc electroplated steel or plastic, color coded silver or gray, listed for use in plenum spaces, with a minimum of 1 inch-wide cable support area, and rated for use with Category 6A UTP and similar cables. J-hooks shall be spaced a maximum of 5 feet apart. J-hooks installed to support telecommunication cables shall not be used to support any other types of cables.

Wireways and Underfloor Duct Systems

Power poles and surface raceways are generally not preferred, but power poles may be used to serve furniture systems in renovations. Surface raceways may be used to serve multiple outlet locations in renovations, at laboratory and computer benches, or for surface mount cable routing where conduit is inappropriate. Underfloor duct systems may be used to serve furniture not located against a wall, but only if cables can be easily replaced. Provide 20 percent spare cable capacity for future use. Provide dividers between power and telecommunication wiring.

Conduit connections to power poles and multi-outlet surface-mounted raceways shall be a minimum of 1 1/4 inches. Provide 6 inch x 6 inch x 4 inch junction boxes when necessary to transition to the top of power poles. Provide conduits to both ends of surface-mounted raceways containing high outlet densities. Maintain the cable minimum bend radius at all times.

Wireways may be built into furniture systems including wall partitions, auditorium seating, desks and laboratory benches, but only if the cable minimum bend radius is maintained at all times and the cables can be easily replaced.

Floor surface and under-carpet cable covers are strongly discouraged and may be used only where approved by ITSComm.

Work Area Outlets

Provide sufficient Work Area Outlets to meet current and anticipated future needs. Coordinate with the Design Manager and ITSComm to determine User needs. Consider the following:

- Most outdoor areas and parking structure floors require at least one emergency telephone.
- Laboratory suites and Housing facility lobbies typically require a campus telephone.
- Animal housing facilities typically require data connections to animal room monitoring panels.
- Housing facility student rooms require one data outlet per pillow, one voice outlet per room, and one RG-6 coaxial cable TV outlet per room.
- Medical facility patient waiting rooms typically require an RG-6 coaxial cable TV outlet.
- Housing facility laundry rooms require one data outlet per clothes washer, one per clothes dryer, and one for the Blue Bucks control panel.
- Offices typically require two outlets, one on each wall perpendicular to the door wall.
- Elevator controllers, unit substation watt-hour meters, building energy and water meters and sub-meters, and the building's main temperature control DDC system head end control panel typically require data connections.
- Parking attendant booths, cash registers in cafes and shops, Blue Bucks control panels and vending machines typically require data connections.
- Audio/visual racks and devices, classroom and conference room scheduling panels, and many lighting control panels and control devices require data connections.

- Buildings with U-M Wireless Network service require outlets for Wireless Access Point (WAP) devices. Request ITSComm to identify WAP outlet locations.

Outlet boxes shall be 4-11/16 inch sheet metal outlet boxes a minimum of 2-1/8 inches deep, with a double-gang plaster ring, except wall telephone outlet boxes shall have a single-gang plaster ring. ITSComm will provide the outlet box faceplates.

Provide floor boxes and poke-throughs sized to accommodate all power, data and audio/visual receptacles and jacks required for the project. Provide spare capacity for future use, dividers between power and telecommunication wiring, and cable training space to maintain cable minimum bend radii. Covers shall be flush, captive, and shall not pop open when rolled on by cart wheels or when stepped on with high heel shoes. Floor boxes and poke-throughs shall be approved by ITSComm.

Grounding, Bonding and Electrical Protection Requirements

Provide a 1/4 inch x 1 inch x 12 inch copper ground bus bar in each BE and TR, and connect each to the ground bus bar in the nearest electrical panel on the same floor with a No. 6 AWG, green insulated, stranded copper ground wire. See Design Guideline SBA-C.

Provide a No. 6 AWG, green insulated, continuous stranded copper ground wire from each TR ground bus bar to the BE room ground bus bar, and from the BE room ground bus bar to the main building ground bus bar (usually located in the unit substation room). The resistance to building ground shall be 1 ohm maximum.

Provide protection for ground wires subject to physical damage or abuse. Non-metallic conduit is preferred. Where metallic conduit is used, bond the conductor to the conduit at both ends.

Bond telecommunication conduits to cable trays using listed grounding bushings and ground straps or using listed conduit grounding clamps. Bond conduits, cable trays, metallic wireways and metallic underfloor duct systems to the nearest BE or TR ground bus bar with No. 12 AWG, green insulated, stranded copper ground wire.

Bond telecommunication cable shields on one end to the nearest BE or TR ground bus bar.



EMERGENCY TWO-WAY COMMUNICATIONS

Scope

Provide special communications systems when required by the Program Documents, including intercom, public address, sound, CCTV and other special systems.

Design Requirements

Locate speakers and similar remote devices so that they are accessible for maintenance by the use of a ladder only. No lifts or scaffolding shall be required to perform maintenance.

Locate the system controls where they are convenient to the people authorized to control the system, but where they are not convenient to the general public.

Equipment Requirements

The system shall be resistant to damage from power system surges, spikes and voltage dips.

When a special device such as a wireless remote control is required to control the system, provide at least 1 such device as part of the system.

All wiring for the system shall be in conduit or surface raceways. Use concealed conduit whenever possible and practical. When concealed conduit can not be used in finished areas, provide surface raceways.

Route the system wiring in separate conduits or surface raceways from the other building wiring.

The types of cables used shall be in accordance with the system manufacturer's instructions.

Installation Requirements

Instruct the Contractor to protect from damage all system devices installed prior to completion of other construction in the area. The Contractor shall correct at his own expense any loss or damage occurring to system devices before completion of other construction.

Instruct the Contractor to perform testing in accordance with Section 16950, and to provide the University Project Manager with test reports.



CLOCK SYSTEMS

Scope

Provide clocks and clock accessories to the extent required by the Owner's Project Requirements (OPR) document.

Related Sections

U-M Master Specification Sections:
[275313 –Clock Systems](#)

Design Requirements

For new buildings, building additions and major renovation projects, provide GPS wireless clocks. Submit a request to the U-M Fire Protection Shop (through the Design Manager) to perform an analysis of the GPS signal strength in the project area. Provide a GPS signal transmitter if necessary to assure adequate GPS signal strength.

For smaller renovation projects, match the building's current clock system if the current clock system is working adequately. If the current clock system is not working adequately, provide GPS wireless clocks.

Use U-M Master Specification 16730 to specify GPS wireless clocks and signal transmitters. When matching the building's current clock system, contact the U-M Fire Protection Shop for their recommendations on specification requirements.

Equipment Requirements

In general, provide 120 volt powered, GPS signal synchronized, wireless, single face wall mounted or double face edge mounted, analog clocks. Battery powered GPS wireless clocks may be used only when approved by the Users and only when the Users acknowledge they must periodically replace the batteries.

In general, clocks shall be 12.5 inch nominal diameter with white faces, polycarbonate frames (color by the A/E), polycarbonate lenses, black standard numerals and sweep second hands.

When a GPS signal transmitter is required, coordinate with the clock manufacturer and specify the appropriate 1 watt output model. Locate the transmitter in accordance with the manufacturer's instructions.

Installation Requirements

Clocks in classrooms should be located on side walls so they are visible to both the professor and the students.

Provide a simplex NEMA 5-20R receptacle in a flush-mounted single gang outlet box to power each 120 volt clock and GPS signal transmitter.

Provide the clock manufacturer's standard lock-type hanger which requires a sequence of movements to install and remove the clock.



SECURITY SYSTEMS

Scope

Provide a security system when required by the Program Documents.

Provide a security system that connects to a Larse Class A remote transmitting unit in each building for notification at the Church Street Security Office. The system shall have proprietary Class B circuits.

Design Requirements

Locate sensors so that they are accessible for maintenance by the use of a ladder only. No lifts or scaffolding shall be required for maintenance.

Locate the security system control panel in a clean, dry, heated and ventilated closet or electrical room near a building entrance. Locate the panel in the same closet or room as the fire alarm system control panel or Larse panel if possible. The panel shall not be located in a building corridor, loading dock area or other high traffic area.

Equipment Requirements

The security system shall be resistant to damage from power system surges, spikes and voltage dips. The system shall be emergency battery backed.

The security system shall be field programmable. When a special device is required to perform field programming, 1 programmer shall be provided as part of the system unless the University already owns an appropriate programmer.

All wiring for the security system shall be in conduit or surface raceways. Use concealed conduit whenever possible and practical. When concealed conduit cannot be used in finished areas, provide surface raceways.

Route security system wiring in separate conduits or surface raceways from the other building wiring.

Installation Requirements

Instruct the Contractor to wire the sensors in each zone in numerical order beginning with the detector closest to the control panel, and progressing away from the control panel.

Instruct the Contractor to provide a typed list identifying all zones and sensors, including the sensor types and locations.

Instruct the Contractor to perform testing in accordance with Section 16950, and to provide the University Project Coordinator with test reports.



FIRE DETECTION AND ALARM

Scope

Provide a fire alarm system, or expand the existing system, as required by Code, the requirements in the [Special Instructions to Designers \(SID\)](#) of the Design Guidelines, and/or as noted in the Program Documents.

The Department of Public Safety (DPS) remotely monitors essentially all of the University buildings on the Ann Arbor campuses. DPS monitors all of these fire alarm systems, 24-hours a day. The connection from the building to DPS is by the University MOSCAD system. This system is UL approved for Central Station monitoring, and the DPS office is considered to be a constantly attended location.

In other locations and/or when noted in the program documents, the fire alarm system shall be connected by telephone to the fire department in that jurisdiction.

Provide shop drawings for approval, and final certification reports, to the State Office of Fire Safety, and/or University of Michigan Fire Marshall (Department of Public Safety), as required by Code, and the Design Guidelines

MOSCAD (Central Station Monitoring) Connection

The fire alarm system shall have output contacts that will interconnect with the University of Michigan's MOSCAD (Motorola SCADA system) transmitting unit. Provide a minimum of three form "C" contacts in the fire alarm control panel, plus needed conduit and wiring to the MOSCAD panel, for use as Alarm, Trouble, and Supervisory inputs for the MOSCAD system. These contacts, in their normal state, shall be closed, and in the 'alarm' state they shall open. See Detail 16725012 for installation details

Note that the MOSCAD system is connected by radio to the University of Michigan's Department of Public Safety on Kipke Road on south campus. This MOSCAD system is often used to transmit other alarm messages to that central security office. These other alarms might include security, and/or monitoring points of critical systems

In new buildings and when defined in the program statement, install, wire, and connect a MOSCAD system. The MOSCAD 'RTU', and antenna equipment will be provided by the University. Installation shall comply with the above noted standard detail, and information included in the program statement.

All wiring in the RTU, between the Alarm Junction Box and the RTU, and the wiring to the antenna, as well as all of the programming and work needed at DPS will be by the University. *(Note to U of M Design Manager, include \$8000 in the project budget to pay for these U of M provided equipment and services.)*

Initiating devices

Provide adequate smoke and heat detectors where required by Code to rapidly detect a fire in any area of the building. In buildings or areas without sprinklers, provide total coverage. In fully sprinklered buildings, Code only requires automatic detectors in elevator machine rooms, in elevator lobbies, and in most elevator hoistways of high rise buildings. In all buildings, Code requires one smoke detector above the fire alarm control panel. In addition, provide supplementary initiating devices as noted below in the 'Design Requirements' section

Provide manual pull stations in all buildings at exit doors and at other locations as defined by Code.

Pull stations in residence areas of residence halls, areas where children are present, and as noted in program statement shall have vandal covers with audible alarm (when cover is lifted). Smoke and heat detectors in resident areas of residence halls, and areas with ceilings of 8'-0" or less, and as noted in program statement shall have wire screen covers that are UL listed for the fire alarm system being installed.

Notification Appliances

Provide audible notification appliances as required to meet the minimum sound levels of the applicable codes. Assume that all interior doors are closed. Take into consideration the average ambient sound level in each space, the distance from the nearest notification appliance to each space, and the sound attenuation of the intervening walls and doors. Note that many laboratories and mechanical rooms have high average ambient sound levels. Note also that alarm sound level measurements will be taken during fire alarm system testing, and audible appliances will have to be added if the alarm sound levels do not meet Code.

High rise buildings, residence halls (in general), buildings having more than 1000 occupants and/or other buildings as noted in program statement, shall have emergency voice/alarm communication systems throughout the building (including speakers in elevator cars).

Provide visual notification appliances in all common and public spaces as required by the applicable codes. Common and public spaces are defined as corridors, toilet rooms, auditoriums, classrooms, multi-person offices, and conference rooms and laboratories with an occupancy large enough that Code requires them to have two doors.

In addition, provide supplementary visual notification appliances as noted below in the 'Design Requirements' section.

To address UFAS (the University's ADA requirements), install a visual (or audible/visual) notification appliance adjacent to each exit sign.

Vivariums shall have special alarm audible and visual indicating appliances to accommodate the research animals. See SBA-A for the specific requirement in these areas.

Connections to Sprinkler Systems

In a building with a sprinkler system, provide water flow switches to detect sprinkler activation; and valve tamper switches at all shut off valves (including elevator machine room

sprinkler shut off valves). Fire panel descriptors shall specifically note coverage area of the water flows, and the locations of the tamper switches. In a building with a fire pump, provide surveillance of the pump and its power supply.

Design Requirements

General Items

All new fire alarm systems shall be addressable with one or more panels as required by the size of the project area. In addition, all new fire alarm systems shall be installed with 25%(additional) spare capacity in all initiating circuits, notification appliance circuits,, power supplies, amplifiers, and related components of the overall system.

Whenever possible, expand and/or extend the existing system unless otherwise directed by the University. The expanded system shall also meet the 25% spare capacity requirement as noted above, limited only by the constraints of the model and vintage of that existing system.

All addressable devices shall have a unique address, this address shall be noted on the as-built drawings, and will be noted on a label for the device. Whenever possible number the heat and smoke detectors in each zone in a numerical order beginning with the detector closest to the control panel, and progressing away from the control panel.

Initiating Devices and Notification Appliances

All initiating, monitoring, and control devices shall have the addressability function built into the associated device. Non-intelligent devices with separate addressable circuit boards are not acceptable.

Monitored components such as flow switches, tamper switches, etc. shall be connected (and monitored) by addressable 'monitor module' device. Monitor modules shall be connected to the monitored device, and shall be in close proximity to that device.

Pull stations, duct smoke detectors, audible and visual notification appliances, etc. shall all be installed and spaced as required by Code, and manufacturer's requirements.

Design Issues

Initiating Devices

Buildings owned by the University without a sprinkler system shall have smoke and/ or heat detectors installed throughout the building.

In buildings with a sprinkler system, install smoke and heat detectors only in areas required by Code, as otherwise required by these guidelines, and good practice. If a building is partially sprinkled, follow the above noted guidelines in the appropriate areas.

Elevators are required by the Elevator Code to be provided with smoke detectors in the elevator machine rooms, in the elevator lobbies, and in most elevator hoistways to initiate an elevator recall. These smoke detectors will be provided with the elevator, and they shall not be connected to the fire alarm system.

When fire alarm system smoke detectors are required in elevator machine rooms and elevator lobbies, provide independent fire alarm system smoke detectors adjacent to the elevators' detectors. If the elevator hoistways are sprinklered, provide an independent fire alarm system smoke detector at the top of each elevator hoistway.

Install heat detectors, rather than smoke detectors, in high humidity locations such as bathrooms with showers and laundry areas, and/or in areas with occasional smoke present such as kitchens.

In areas where the room will be occasionally hosed down (cleaned) use devices specifically listed for such duty. For outdoor locations, use devices listed for the environment in which they will be located.

Locate all initiating devices (detectors) so that they are accessible for maintenance by the use of a ladder only. No lifts or scaffolding shall be required for maintenance. Those devices in restricted areas such as elevator shafts shall be easily accessible, from a non-restricted area, via an access doors. Avoid locating detectors above sloped auditorium floors.

Do not locate detectors at the top of atriums or skylights. In these applications use beam type where applicable. Avoid locating detectors where direct sunlight, high humidity, stagnant air, or turbulent air will cause maintenance problems.

When the need for door holders (and associated door release service devices) is defined during schematic design, the associated devices shall be connected to the fire alarm system. The needed smoke detectors shall report the fire alarm system, and the door holders are then released by the fire alarm system. Carefully coordinate associated fire system components and door hardware specified in the architectural section.

Duct Smoke Detectors

1. Locate duct smoke detectors at locations defined by manufacturer and/or by the mechanical contractor to have a laminar flow across the detector. Do not locate duct type smoke detectors downstream of humidity injection points or in outside air intake plenums. Duct smoke detectors shall 'report' to the fire alarm panel, and the fire alarm panel shall operate a 'control module' to stop the associated fan.
2. All duct smoke detector installations shall include a 'duct detector interface box' as shown in standard details 16720006, 16720007, or 16720008. The University will provide the interface box, unless noted otherwise during schematic design.
3. Locate the duct detector and the interface box so that a ladder is not needed to access them. Typically the boxes are located near the associated temperature control panel.. If the duct detector must be located where it is inaccessible or a ladder is required to access it, provide a remote indicator light and test pushbutton in a nearby accessible, non-public location.

4. If the fire alarm system is connected to a MOSCAD panel for transmission of alarm, supervisory, and trouble signals to the Department of Public Safety, program the duct detectors as supervisory rather than alarm devices. Duct detectors shall only alarm the building if the fire alarm system is not connected to MOSCAD.

Notification Appliances

1. Audible notification appliances shall produce a slow whoop alarm tone. If an emergency voice/alarm communication system is provided, the audible evacuation alarm signal shall produce three slow whoop alarm tones followed by a pre-selected voice evacuation message. The alarm tones and voice evacuation messages shall alternate until they are silenced.
2. Size and locate visible notification appliances in strict accordance with the "Visible Characteristics, Public Mode" Section of NFPA 72. Select the strobe candela outputs in accordance with the spacing tables, and indicate their outputs on the plan drawings for all strobes greater than 15 candela. Locate strobes at the halfway distance on the longest walls as shown in the NFPA 72 figures and appendices. Do not install strobes near room corners without increasing their candela ratings appropriately.

Fire Alarm Main Panels, and Annunciators

1. Locate the fire alarm system control panel in a clean, dry, heated, and ventilated closet or electrical room near a building entrance. The panel shall not be located in a building corridor, loading dock area or other high traffic area.
2. Provide at the fire department's normal entrance a fully functional annunciator panel.
3. In areas that are not continuously occupied, automatic smoke detection shall be provided at each control unit(s) location to provide notification of fire at that location.
4. The fire alarm system annunciation shall enable responding personnel to quickly and accurately identify the location of a fire, and to indicate the status of emergency equipment or fire safety functions that might affect the safety of occupants in a fire situation. All required annunciation means shall be readily accessible to responding personnel and shall be located as required by the authority having jurisdiction to facilitate an efficient response to the fire situation.

On all buildings on the Ann Arbor Campuses, install a NEMA 3R rated, 90 to 100 candela, strobe, outside, and above the location of the 'siamese' (hose) connection devices. This is a requirement of the Ann Arbor Fire Department

Supplementary Devices and Appliances

Provide supplementary initiating devices, of the type noted, for the following applications. Provide these devices so that a small fire can be detected and extinguished before the sprinkler system actuates and destroys the energized electrical equipment. Since these are not NFPA 72 requirements, place a note on the plan by each such device noting the reason for its placement. The note is to clarify the reason for the device, and to insure that the device is being and installed and placed to 'cover' the noted equipment or space. Unless

otherwise required by Code, or these guidelines, there is no need to provide 'complete room coverage' in these situations - in all other respects the installation shall meet NFPA 72 requirements

1. In substation rooms provide two heat detectors per transformer. Center them on the transverse centerline of the substation transformer, and place approximately above the front, and rear surfaces, of the transformer.
2. In BDF (BE) and LDF (TR) communication rooms, provide at least one smoke detector above the relay racks.
3. In electrical power rooms, provide at least one smoke detector.
4. In recycling and trash rooms, install one smoke detector.
5. In elevator machine rooms and elevator lobbies of low rise buildings, provide one smoke detector.

Provide supplementary notification appliances, of the type noted, for the following applications. Provide these devices to notify people in areas with a high ambient sound level of a fire. Since these are not NFPA 72 requirements, place a note on the plan drawing by each such appliance noting the reason for its placement. Unless otherwise required by Code, or these guidelines, there is no need to provide 'complete room coverage' in these situations - in all other respects the installation shall meet NFPA 72 requirements.

1. In large mechanical rooms, elevator machine rooms, and electrical substation rooms, provide visual notification appliances if it is unlikely that the audible notification appliances will produce a sound level at least 15 dBA above the average ambient sound level.
2. In laboratories containing mechanical equipment, provide visual notification appliances if it is unlikely that the audible notification appliances will produce a sound level at least 15 dBA above the average ambient sound level.

Products

The fire alarm system shall be resistant to damage from power system surges, spikes and voltage dips. The system shall be emergency battery backed, and size in accordance with Code requirements.

To reduce the possibility of damage by induced transients, circuits and equipment shall be properly protected in accordance with requirements set forth in NFPA 70, National Electrical Code, Article 800.

The fire alarm system shall be field programmable. When a special device is required to perform field programming, 1 programmer, software, and training shall be provided as part of the system unless the University already owns an appropriate programmer.

All wiring for the fire alarm system shall be installed in conduit or surface raceways. Use concealed conduit whenever possible and practical. When concealed conduit cannot be used in finished areas, provide surface raceways.

Route fire alarm system wiring in separate conduits (or surface raceways) from that of other building wiring. In addition, power, alarm, and detector wiring shall be segregated from each other as required by the system manufacturer and the applicable codes.

Execution

Instruct the Contractor to wire the detectors in each zone in numerical order beginning with the detector closest to the control panel, and progressing away from the control panel.

Instruct the Contractor to provide a typed list identifying all zones and detectors including the detector types and locations.

Inform the Contractor that the fire alarm system control panels, alarm devices, detectors, and switches shall not be painted. Junction boxes and covers, however, shall be painted red.

Detectors shall not be installed until after the construction clean up of all trades is complete and final. Detectors that have been installed prior to final clean up by all trades shall be cleaned or replaced.

Duct type detectors shall not be installed in the ducts until after the ducts have been cleaned and the duct filters have been changed.

Inform the Contractor that ceiling mounted detectors shall either not be installed prior to completion of other construction work in the area, or plastic bags shall cover the detectors until the other construction work is completed

Fire alarm system shall be connected, programmed, tested, and certified, by NICET certified fire alarm persons. Raceway, wiring, and installation shall be by licensed electricians. The fire alarm contractor shall provide the University, on floppy disk, or CD, a complete 'Windows System' compatible copy of the operational and application programs. This electronic documentation will reflect the system as configured after the certification testing is completed, and accepted.

Instruct the Contractor to perform testing in accordance with Section 16950, and to provide the University Project Coordinator with test reports.



- HOME
- ABOUT US
- PROJECTS
- MAPS & DETOURS
- MASTER PLANNING
- POLICIES & PROCEDURES
- SUSTAINABILITY
- SAFETY

- FOR U-M CLIENTS
- FOR VENDORS
- FOR U-M AEC STAFF

OUT TO BID

DESIGN GUIDELINES

CODES & REGULATORY AGENCIES

DESIGN DELIVERABLES

SUSTAINABILITY

SPECIAL INSTRUCTIONS TO DESIGNERS

SPECIAL BUILDING AREAS

OFFICE SPACE

TECHNICAL SECTIONS

STANDARD DETAILS

MASTER SPECIFICATIONS

PREFERRED MANUFACTURERS

HEALTH SYSTEM PROJECTS

EFFECTIVE DATE

BUILDING COMMISSIONING

CONTRACTS & AGREEMENTS

CONTRACTOR RESOURCES

OTHER LINKS

STANDARD DETAILS

Standard Details express typical University requirements, and thus should be used in place of the equivalent A/E detail. Professional judgment is required to make Standard Details project specific.

Special Building Areas	Last Updated	PDF	Microstation	AutoCAD	IES
Custodial Closets	May 2003	PDF			
Custodial Storage	May 2003	PDF			

General Requirements Details

01141001 – Tree Protection	August 2004	PDF	Microstation
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Architectural Design Details


























Mechanical Design Details, Schedules and Tables











Water Softener for Boilers System Schematic	November 2005	PDF	Microstation	AutoCAD
R.O. Make – up System for Clean Steam Humidification System	November 2005	PDF	Microstation	AutoCAD
High Purity Water System Schematic	November 2005	PDF	Microstation	AutoCAD
15060 Basic Piping Materials & Methods				
Piping System Pressure Test Table	December 2009	PDF	Microstation	AutoCAD
15100 Valves				
15100 02 11 09 – DHW Valve Installation Detail	December 2009	PDF	Microstation	AutoCAD
15125 – Expansion Joint Schedule	March 2008	PDF	Microstation	AutoCAD
15125 – Expansion Joint Installation Detail	March 2008	PDF	Microstation	AutoCAD
15125 – Expansion Joint Detail Domestic Hot Water	March 2008	PDF	Microstation	AutoCAD
15125 – Expansion Joint Detail LPS, HPS and LPC	March 2008	PDF	Microstation	AutoCAD
15130001 – Thermometer Installation Detail	June 2006	PDF	Microstation	AutoCAD
15130002 – Pressure Gauge Detail	June 2006	PDF	Microstation	AutoCAD
15160001 – End Suction Pump Installation Detail	November 2012	PDF	Microstation	AutoCAD
15160002 – Pump Base Installation Detail	November 2012	PDF	Microstation	AutoCAD
15160003 – Vertical Split Case Pump Installation Detail	November 2012	PDF	Microstation	AutoCAD
15160004 – In-Line Pump	November 2012	PDF	Microstation	AutoCAD
15188001 – Steam Boiler Water Treatment Schematic	June 2006	PDF	Microstation	AutoCAD
15189001 – Closed System Shot Feeder Detail	September 2012	PDF	Microstation	AutoCAD
15189002 – Glycol Feed System Detail	September 2012	PDF	Microstation	AutoCAD
1518903 – Closed System Make-Up Detail	November 2012	PDF	Microstation	AutoCAD
15250001 – Blanket Fiberglass Insulation Detail	December 2003	PDF	Microstation	AutoCAD
15300 001 – Fire Service System Detail	February 2014	PDF	Microstation	AutoCAD
15320 001 – Fire Pump System Detail	March 2013	PDF	Microstation	AutoCAD
15411 001- Domestic Water Service System Detail	March 2013	PDF	Microstation	AutoCAD
15515002 – Automatic Water System Air Vent Detail	June 2006	PDF	Microstation	AutoCAD
15515011 - Coalescing Separator and Floor MountedExpansion Tank Detail	November 2012	PDF	Microstation	AutoCAD
15525 Steam Specialties				
D 15525 05 11 09 – Bucket Steam Trap Assembly Detail	December 2009	PDF	Microstation	AutoCAD
D 15525 01 11 09 – F&T Steam Trap Assembly Detail	December	PDF	Microstation	AutoCAD

2009				
15558001 – Steam Boiler Schedule	March 2004	PDF 	Microstation	AutoCAD
15559001 – Preheat Boiler Feed Unit and Pump Schedule	March 2004	PDF 	Microstation	AutoCAD
15684001 – Electric Drive Water Cooled Chiller Piping Schematic	November 2012	PDF 	Microstation	AutoCAD
15684001 – Electric Water Cooled Centrifugal/Screw/Scroll Chiller Schedule	November 2012	PDF 	Microstation	AutoCAD
15684002 – Air Cooled Chiller Schedule	November 2012	PDF 	Microstation	AutoCAD
15710 Cooling Towers				
15710001 – Cooling Tower LPS Piping Detail	June 2008	PDF 	Microstation	AutoCAD
15710003 – Cooling Tower Schedule	December 2008	PDF 	Microstation	AutoCAD
15710004 – Seasonal Tower Piping Detail	June 2008	PDF 	Microstation	AutoCAD
15710010 – Condenser Water Treatment Equipment Diagram (Bromine Method)	June 2013	PDF 	Microstation	AutoCAD
15820001 – Hot Water Heating Coil Detail 2-Way Control Valve	June 2006	PDF 	Microstation	AutoCAD
15820002 – Hot Water Heating Coil Detail 3-Way Control Valve	June 2006	PDF 	Microstation	AutoCAD
15820101 – Chilled Water Cooling Coil Detail 3-Way Control Valve	June 2006	PDF 	Microstation	AutoCAD
15820102 – Chilled Water Cooling Coil Detail 2-Way Control Valve	June 2006	PDF 	Microstation	AutoCAD
15820201 – Steam Heating Coil	June 2003	PDF 	Microstation	AutoCAD
15830001 – Draw-Thru Coil Condensate Drain	July 2009	PDF 	Microstation	AutoCAD
15830101 – Duct-Mounted Reheat Coil – Hot Water Heating Piping Connections	July 2009	PDF 	Microstation	AutoCAD
15830102 – Blow-Thru Coil Condensate Drain	July 2009	PDF 	Microstation	AutoCAD
15851101 – Fan Coil Unit Installation Detail	July 2009	PDF 	Microstation	AutoCAD
15890001 Sample Duct Construction Schedule	August 2011	PDF 	Microstation	AutoCAD
15895001 Sample Damper Construction Schedule	August 2011	PDF 	Microstation	AutoCAD
15896001 – Supply Air TAU Clearance Detail	May 2009	PDF 	Microstation	AutoCAD
15910001 – Supply Air LTAU Clearance Detail	September 2008	PDF 	Microstation	AutoCAD
15910001 – Laboratory Terminal Airflow Units Sample Schedules	September 2008	PDF 	Microstation	
15975001 – Differential Pressure Transmitter Installation Detail (Liquid)	June 2006	PDF 	Microstation	AutoCAD
15975002 – Typical DDC Panel Assembly	June 2006	PDF 	Microstation	AutoCAD
Tunnel Toolkit				
Title Block (reference)	June 2006	PDF	Microstation	AutoCAD
TK – 1	June 2006	PDF 	Microstation	AutoCAD
2331m101 (reference 1)	June 2006	PDF	Microstation	AutoCAD
2331t101 (reference 2)	June 2006	PDF	Microstation	AutoCAD
TK – 2	June 2006	PDF 	Microstation	AutoCAD
TK – 3	June 2006	PDF 	Microstation	AutoCAD
TK – 4	June 2006	PDF 	Microstation	AutoCAD
TK – 5	June 2006	PDF 	Microstation	AutoCAD
TK – 6	June 2006	PDF 	Microstation	AutoCAD
TK – 7	June 2006	PDF 	Microstation	AutoCAD

















TK – 8	June 2006	PDF 	Microstation	AutoCAD	
Electrical Standard Details	Last Updated	PDF	Microstation	AutoCAD	IES
26051301 – Aluminum Wire Terminations	April 2014	PDF 	Microstation	AutoCAD	
26051302 – Aluminum Conductor Option	April 2014	PDF 	Microstation	AutoCAD	
26052601 – Ground Bus Detail	November 2013	PDF 	Microstation	AutoCAD	
26052602 – Isolated Ground Receptacle Wiring Diagram-alt	March 2014	PDF 	Microstation	AutoCAD	
26052603 – Transformer Pad Grounding Detail-alt	March 2014	PDF 	Microstation	AutoCAD	
26052604 – Manhole Grounding	April 2014	PDF 	Microstation	AutoCAD	
26052605 – Power Manole Grounding With Non-metallic Racks	March 2014	PDF 	Microstation	AutoCAD	
26052606 – Typical Column Grounding Detail	March 2014	PDF 	Microstation	AutoCAD	
26052607 – Ground Bus Detail Telcom	March 2014	PDF 	Microstation	AutoCAD	
26052608 – Power Manhole For High Water Table Grounding With Non-metalic Racks	March 2014	PDF 	Microstation	AutoCAD	
26053301 – Conduit Penetration Thru Existing Floor	April 2014	PDF 	Microstation	AutoCAD	
26053302 – Conduit Penetration Thru New Floor	April 2014	PDF 	Microstation	AutoCAD	
26053303 – Hilti Conduit Penetration	April 2014	PDF 	Microstation	AutoCAD	
26053304 – Conduit Penetration Thru Existing Roof	April 2014	PDF 	Microstation	AutoCAD	
26053305 – Conduit Penetration Thru Roof	April 2014	PDF 	Microstation	AutoCAD	
26053306 – Conduit Penetration Thru New Roof	April 2014	PDF 	Microstation	AutoCAD	
26053307 – New Conduit Thru New Membrane Roof	April 2014	PDF 	Microstation	AutoCAD	
26053308 – Existing Conduit Thru New Membrane Roof	April 2014	PDF 	Microstation	AutoCAD	
26053309 – Conduit Roof Support	April 2014	PDF 	Microstation	AutoCAD	
26053310 – Conduit Wall Penetration	April 2014	PDF 	Microstation	AutoCAD	
26053311 – Conduit Penetration Thru Interior Wall	April 2014	PDF 	Microstation	AutoCAD	
26053312 – Bench & Wall Plugmold Detail	April 2014	PDF 	Microstation	AutoCAD	
26053313 – Dual Channel Raceway Installation	April 2014	PDF 	Microstation	AutoCAD	
26053314 – Dual Channel Surface Raceway	April 2014	PDF 	Microstation	AutoCAD	
26053315 – Metallic Raceway With Modular Furniture Feed	April 2014	PDF 	Microstation	AutoCAD	
26053316 – Dual Channel Faceplate Installation	April 2014	PDF 	Microstation	AutoCAD	
26053317 – Benchtop Vertical Raceway Power	April 2014	PDF 	Microstation	AutoCAD	
26053318 – Benchtop Vertical Raceway Data	April 2014	PDF 	Microstation	AutoCAD	
26053319 – End Of Bench Vertical Raceway	April 2014	PDF 	Microstation	AutoCAD	
26053320 – Dual Channel Non-metallic Raceway	April 2014	PDF 	Microstation	AutoCAD	
26053321 – Dual Channel Non-metallic Raceway	April 2014	PDF 	Microstation	AutoCAD	
26053322 – Non-metallic Surface Raceway	April 2014	PDF 	Microstation	AutoCAD	
26053323 – Wire Harness	April 2014	PDF 	Microstation	AutoCAD	
26053324 – Ceiling Mounted Speaker	April 2014	PDF 	Microstation	AutoCAD	
26053325 – Hanging Receptacle	April 2014	PDF 	Microstation	AutoCAD	
26053328 – Wall Mtd Ups Recep Pnl Detail	April 2014	PDF 	Microstation	AutoCAD	
26053329 – Power Furniture Interface Detail	April 2014	PDF 	Microstation	AutoCAD	
26053330 – Cable Tray Mounting Detail	April 2014	PDF 	Microstation	AutoCAD	
26053331 – Aluminum Indoor Cable Tray Clamping Detail	April 2014	PDF 	Microstation	AutoCAD	
26053332 – Center Hung Cable Tray	April 2014	PDF 	Microstation	AutoCAD	
26053333 – Cable Tray Penetration Through Fire Rated Wall	April 2014	PDF 	Microstation	AutoCAD	

26053334 – Tray Mounted Raceway	April 2014	PDF  Microstation AutoCAD
26053335 – Fumehood Electrical Service Detail	April 2014	PDF  Microstation AutoCAD
26053336 – Walk-in Fumehood Electrical Service Detail	April 2014	PDF  Microstation AutoCAD
26053337 – Island Bench Detail	April 2014	PDF  Microstation AutoCAD
26053338 – Window Ac Unit Electrical Detail	April 2014	PDF  Microstation AutoCAD
26053339 – Power-telephone & Data Cable Connections	April 2014	PDF  Microstation AutoCAD
26053340 – Av Raceway Detail	April 2014	PDF  Microstation AutoCAD
26053341 – Power Pole Detail	April 2014	PDF  Microstation AutoCAD
26053342 – Vertical Raceway For Existing Walls	April 2014	PDF  Microstation AutoCAD
26054301 – Underground Power Duct Sections	July 2014	PDF  Microstation AutoCAD
26054302 – Underground Telecommunication Duct Sections	April 2014	PDF  Microstation AutoCAD
26054303 – Duct Bank Spacer & Reinforcing Details	April 2014	PDF  Microstation AutoCAD
26054304 – 10x10x7 Pre-cast Power Manhole	April 2014	PDF  Microstation AutoCAD
26054305 – 12x5x6-6 Pre-cast Telecommunications Manhole	April 2014	PDF  Microstation AutoCAD
26054306 – 8-8x8-8x7 Pre-cast Power Manhole	April 2014	PDF  Microstation AutoCAD
26054307 – 8x4x6 Pre-cast Telecommunications Manhole	April 2014	PDF  Microstation AutoCAD
26054308 – Detroit Edison Manhole	April 2014	PDF  Microstation AutoCAD
26054309 – Neck & Cover Details For Cast In Place Manholes	April 2014	PDF  Microstation AutoCAD
26054310 – Angle Entrance Detail At Manholes	April 2014	PDF  Microstation AutoCAD
26054311 – Duct Reinforcing At Manholes-vaults-buildings	April 2014	PDF  Microstation AutoCAD
26054312 – Cable Support Detail Within Power Manholes	April 2014	PDF  Microstation AutoCAD
26054313 – Cable Support Detail Within Power Manholes	April 2014	PDF  Microstation AutoCAD
26054314 – 4x4x4 Pre-cast Itcs Handhole	April 2014	PDF  Microstation AutoCAD
26054316 – Trench Detail	April 2014	PDF  Microstation AutoCAD
26054317 – Post Mounted Underground Service	April 2014	PDF  Microstation AutoCAD
26054319 – Power Manhole Bell End Installation	April 2014	PDF  Microstation AutoCAD
26054320 – Orangeburg To Pvc Transition	April 2014	PDF  Microstation AutoCAD
26054321 – Casing Details With Sled	April 2014	PDF  Microstation AutoCAD
26054322 – 8x6x7 Pre-cast Telecommunications Manhole	April 2014	PDF  Microstation AutoCAD
26054323 – Miss Dig	April 2014	PDF  Microstation AutoCAD
26110001 – Single Ended Substation	April 2014	PDF  Microstation AutoCAD
26110002 – Double Ended Substation	April 2014	PDF  Microstation AutoCAD
26110003 – Substation Fire Pump Disconnect	April 2014	PDF  Microstation AutoCAD
26110004 – Maintenance Back Feed Tap Box	April 2014	PDF  Microstation AutoCAD
26110005 – Concrete Equipment Pad	April 2014	PDF  Microstation AutoCAD
26110006 – Switch Anchoring Detail	April 2014	PDF  Microstation AutoCAD
26110007 – Leveling Channel Detail	April 2014	PDF  Microstation AutoCAD
26200001 – Service Entrance Transformer Wiring Diagram	April 2014	PDF  Microstation AutoCAD
26200002 – Step Down Transformer Wiiring Diagram	April 2014	PDF  Microstation AutoCAD
26200003 – Panel Naming Procedure	April 2014	PDF  Microstation AutoCAD
26272603 – Ceiling Mounted Receptacle Detail	April 2014	PDF  Microstation AutoCAD
26290001 – Mcc One Line Diagram	April 2014	PDF  Microstation AutoCAD
26290002- Control Wiring Diagram	April 2014	PDF  Microstation AutoCAD
26290003 – Motor Control Center Installation Det	April 2014	PDF  Microstation AutoCAD
26510001 – Exit Sign Mounting Detail	April 2014	PDF  Microstation AutoCAD
26510002 – Student Exit Sign Mounting Detail	April 2014	PDF  Microstation AutoCAD

26510003 – Surface Or Hanging Emergency Lighting Fixture	April 2014	PDF  Microstation AutoCAD
26510004 – Elevator Shaft Lighting	April 2014	PDF  Microstation AutoCAD
26510005 -recessed Can Emergency Lighting Fixture	April 2014	PDF  Microstation AutoCAD
26510006 – Emergency Light Battery Exerciser	April 2014	PDF  Microstation AutoCAD
26510007 – Inner Lamp Switch Dim Detail (type F) F Fixtures	April 2014	PDF  Microstation AutoCAD
26510008 – Cable Way- Hallway Cove Light Detail	April 2014	PDF  Microstation AutoCAD
26510009 – Elevator Shaft Lighting	April 2014	PDF  Microstation AutoCAD
26510010 – Recessed Emergency Lighting Fixture	April 2014	PDF  Microstation AutoCAD
26510011 – Schematic For Os F (lights- Hvac Fcu)	April 2014	PDF  Microstation AutoCAD
26510012 – Schematic For Os S (lights Hvac Fcu Dual)	April 2014	PDF  Microstation AutoCAD
26510013 – Schematic For Os F (lights- Hvac)	April 2014	PDF  Microstation AutoCAD
26510014 – High Bay Fixture Mounting	April 2014	PDF  Microstation AutoCAD
26510015 – Cove Light Mounting Detail	April 2014	PDF  Microstation AutoCAD
26560001 – Site Light Schedule	April 2014	PDF  Microstation AutoCAD
26560002 – Riser For Site Lighting Power Source	April 2014	PDF  Microstation AutoCAD
26560003 – Pedestrian Pole Base Against Seatwall	April 2014	PDF  Microstation AutoCAD
26560004 – Site Lighting Trench Detail	April 2014	PDF  Microstation AutoCAD
26560005 – Underground Sleeve Detail	April 2014	PDF  Microstation AutoCAD
26560006 – Typical Pole Wiring Detail	April 2014	PDF  Microstation AutoCAD
26560007 – Single Globe Unit	April 2014	PDF  Microstation AutoCAD
26560008 – Double Globe Unit	April 2014	PDF  Microstation AutoCAD
26560009 – Five Globe Unit	April 2014	PDF  Microstation AutoCAD
26560010 – Street Light Fixture Detail	April 2014	PDF  Microstation AutoCAD
26560011 – Pedestrian Light Pole Base In Pavement	April 2014	PDF  Microstation AutoCAD
26560012 – Pedestrian Light Pole Base In A Seatwall	April 2014	PDF  Microstation AutoCAD
26560013 – Pedestrian Light Pole Base In Lawn	April 2014	PDF  Microstation AutoCAD
26560014 – Parking Lot Fixture Detail	April 2014	PDF  Microstation AutoCAD
26560015 – Pole Base Detail For Walkway Lighting	April 2014	PDF  Microstation AutoCAD
26560016 – Pedestrian Light Wall Mounted	April 2014	PDF  Microstation AutoCAD
26560017 – Pedestrian Pole Base Plan View	April 2014	PDF  Microstation AutoCAD
26560018 – Musco Electrical Enclosure Detail	April 2014	PDF  Microstation AutoCAD
26560019 – Musco Base & Pole Electrical Detail	April 2014	PDF  Microstation AutoCAD
26560020 – Musco Pole Top Assembly Electrical Detail	April 2014	PDF  Microstation AutoCAD
26560021 – Slipfitter Mtd Detail	April 2014	PDF  Microstation AutoCAD
26560022 – Yoke Mtd Detail	April 2014	PDF  Microstation AutoCAD
26560024 – Riser For Building Exterior Lighting Power Source	April 2014	PDF  Microstation AutoCAD
26560025 – Pedestrian Top Wall	April 2014	PDF  Microstation AutoCAD
26560026 – Pedestrian Top Wall	April 2014	PDF  Microstation AutoCAD
26560027 – Parking Lot Fixture Schedule Update	April 2014	PDF  Microstation AutoCAD
27200001 – Bldg Elevation Telecommunication Rm Arrangements	April 2014	PDF  Microstation AutoCAD
27200002 – Elevation Communication Detail	April 2014	PDF  Microstation AutoCAD
27200003 – Telcom Rack Power Detail	April 2014	PDF  Microstation AutoCAD
28130001 – Typ Raceway Installation At Single Door With Electric Strike	April 2014	Request from Design Manager
28130002 – Typ Raceway Installation At Single Door With Electric Moritse Device	April 2014	Request from Design Manager

28130003 – Typ Raceway Installation At Single Door With E-type Electric Panic Device	April 2014	Request from Design Manager	
28130004 – Typ Raceway Installation At Single Door With EI-type Electric Panic Device	April 2014	Request from Design Manager	
28130006 – Typ Raceway Installation At Double Door With EI-type Electric Panic Device	April 2014	Request from Design Manager	
28130007 – Control Wiring For Door Hold Opens	April 2014	Request from Design Manager	
28130008 – Typ Raceway Installation At Doors With Monitoring Sensor	April 2014	Request from Design Manager	
28130009 – Typ Raceway At Single Fire Rated Door	April 2014	Request from Design Manager	
28130010- Card Reader And Door Actuator Mounting	April 2014	Request from Design Manager	
28130011 – Typ Raceway Installation At Door Hold Open Devices	April 2014	Request from Design Manager	
28130012 – Card Reader Pedestal Detail	April 2014	Request from Design Manager	
28130013 – Installation For Main 1st Card Reader Panel Assembly In Bldg	April 2014	Request from Design Manager	
28130014 – Nrc Single Door W Elec Mortice	April 2014	Request from Design Manager	
28160015 – Moscad Rtu Electrical Detail	April 2014	PDF 	Microstation AutoCAD
28160016 – Audio System Block Diag (classrm Hearing Assist)	April 2014	PDF 	Microstation AutoCAD
28160017 – Hearing Assist Antenna(classrm Hearing Assist)	April 2014	PDF 	Microstation AutoCAD
28310001 – Duct Smoke Detector Installation	April 2014	PDF 	Microstation AutoCAD
28310004 – Riser For Hearing Impaired Strobe Detail #3	April 2014	PDF 	Microstation AutoCAD
28310005 – Smoke Det Interface Conn Temp Controls	April 2014	PDF 	Microstation AutoCAD
28310006 – Smoke Det Interface Addressable System	April 2014	PDF 	Microstation AutoCAD
28310007 – Smoke Det Interface Hardwired System	April 2014	PDF 	Microstation AutoCAD
28310008 – Smoke Det Interface No Fire Alarm System	April 2014	PDF 	Microstation AutoCAD
28310009 – Overall Interconnection Diagram	April 2014	PDF 	Microstation AutoCAD

Civil Design Details

Building Identification Sign Detail	August 2013	PDF 	
Concrete Sidewalk Details			
Thickened Edge Walk Detail	April 2009	PDF 	Microstation AutoCAD
Sidewalk Detail	April 2009	PDF 	Microstation AutoCAD
Expansion Joint	April 2009	PDF 	Microstation AutoCAD
Decorative Finishes-Picture Framed	April 2009	PDF 	Microstation AutoCAD
Notes and Specifications	April 2009	PDF 	Microstation AutoCAD
Concrete Curb Details			
Landscape Island Topsoil	April 2009	PDF 	Microstation AutoCAD
Fastener Strip	April 2009	PDF 	Microstation AutoCAD
Light Pole/Concrete Fastener Strip	April 2009	PDF 	Microstation AutoCAD
City of Ann Arbor Curb and Gutter	April 2009	PDF 	Microstation AutoCAD
18" Spillout Curb and Gutter	April 2009	PDF 	Microstation AutoCAD
18" Curb and Gutter (U of M Standard)	April 2009	PDF 	Microstation AutoCAD
Mountable Curb and Gutter	April 2009	PDF 	Microstation AutoCAD
Gutter Section	April 2009	PDF 	Microstation AutoCAD
Standard Straight Curb	April 2009	PDF 	Microstation AutoCAD
New Curb Pavement Patch	April 2009	PDF 	Microstation AutoCAD
Miscellaneous Details			

Brick Paver on Concrete Base	April 2009	PDF	Microstation	AutoCAD
Porous Pavers	May 2012	PDF	Microstation	AutoCAD
Precast Paver on Concrete Base	July 2014	PDF	Microstation	AutoCAD
Bicycle Hoops – Typical Layout	April 2009	PDF	Microstation	AutoCAD
Bicycle Hoops in Mulch	April 2009	PDF	Microstation	AutoCAD
Bicycle Hoops in Pavers	April 2009	PDF	Microstation	AutoCAD
Concrete Bollard	April 2009	PDF	Microstation	AutoCAD
Concrete Wheel Stop	April 2009	PDF	Microstation	AutoCAD
Frost Free Stoop	April 2009	PDF	Microstation	AutoCAD
New Seeded Area	April 2009	PDF	Microstation	AutoCAD
Sign Mount Detail	April 2009	PDF	Microstation	AutoCAD
Concrete Parking Bumper/Drain Type	April 2009	PDF	Microstation	AutoCAD
Typical U of M Emergency Telephone Kiosk		PDF	Microstation	AutoCAD
Emergency Telephone Free Standing (No Power and Telephone Nearby)		PDF	Microstation	AutoCAD
Guardrail	April 2009	PDF	Microstation	AutoCAD
Pavements/Asphalt Pavement Details				
Bituminous Walk/Bike Path	April 2009	PDF	Microstation	AutoCAD
Bituminous Walk Path	April 2009	PDF	Microstation	AutoCAD
Asphalt Drive Section	April 2009	PDF	Microstation	AutoCAD
Milled Edge Detail	April 2009	PDF	Microstation	AutoCAD
Parking Lot Pavement	April 2009	PDF	Microstation	AutoCAD
Road Pavement	April 2009	PDF	Microstation	AutoCAD
Bituminous Curb	April 2009	PDF	Microstation	AutoCAD
Pavements/Concrete Pavement Details				
Longitudinal Lane Tie Joint-Symbol (D)	April 2009	PDF	Microstation	AutoCAD
Transverse Expansion Joint	April 2009	PDF	Microstation	AutoCAD
Concrete Road Cross Section	April 2009	PDF	Microstation	AutoCAD
City of Ann Arbor Type "M" Drive Approach	April 2009	PDF	Microstation	AutoCAD
Porous Concrete	April 2009	PDF	Microstation	AutoCAD
Sanitary Details				
Manhole With Solid Cover	August 2012	PDF	Microstation	AutoCAD
Sanitary Sewer Lead Cleanout	August 2012	PDF	Microstation	AutoCAD
Sanitary Sewer Connection With Riser	August 2012	PDF	Microstation	AutoCAD
Drop Connection Detail	August 2012	PDF	Microstation	AutoCAD
Sanitary Manhole 8" – 30" Sewers	August 2012	PDF	Microstation	AutoCAD
Soil Erosion Details				
Inlet Filter	April 2009	PDF	Microstation	AutoCAD
Inlet Filter-Green Belt	April 2009	PDF	Microstation	AutoCAD
Straw Bale Detail	April 2009	PDF	Microstation	AutoCAD
Silt Sack Detail	April 2009	PDF	Microstation	AutoCAD
Silt Fence	April 2009	PDF	Microstation	AutoCAD
Stone Inlet Filter	April 2009	PDF	Microstation	AutoCAD
Rip-Rap Detail	April 2009	PDF	Microstation	AutoCAD

Anti-Tracking Pad Detail	April 2009	PDF	Microstation	AutoCAD
Soil Erosion and Sedimentation Control Notes	April 2009	PDF	Microstation	AutoCAD
Storm Detail				
Double Storm Inlet	August 2012	PDF	Microstation	AutoCAD
Storm Inlet Section	August 2012	PDF	Microstation	AutoCAD
Storm Inlet In Pavement Section	August 2012	PDF	Microstation	AutoCAD
Storm Inlet Section Yard Drain (Typ.)	August 2012	PDF	Microstation	AutoCAD
Storm Water Retention/ Detention Outlet Restrictor	April 2009	PDF	Microstation	AutoCAD
Slotted Drain Corrugated Galvanized	April 2009	PDF	Microstation	AutoCAD
Concrete Block Inlet – Jct. Chamber	August 2012	PDF	Microstation	AutoCAD
Standard Storm Manhole	August 2012	PDF	Microstation	AutoCAD
4' Catch Basin (Curb Inlet)	August 2012	PDF	Microstation	AutoCAD
Sidewalk Edge Drain	April 2009	PDF	Microstation	AutoCAD
Underdrain	April 2009	PDF	Microstation	AutoCAD
Road Edge Drain	April 2009	PDF	Microstation	AutoCAD
Trench Drain	April 2009	PDF	Microstation	AutoCAD
Typical Underdrain Detail With Existing Curb and Gutter	April 2009	PDF	Microstation	AutoCAD
Outlet Headwall	April 2009	PDF	Microstation	AutoCAD
Trench Details				
Electrical Trench Detail	April 2009	PDF	Microstation	AutoCAD
Utility Trench Green Belt	April 2009	PDF	Microstation	AutoCAD
Utility Trench W/Asp. Patch	April 2009	PDF	Microstation	AutoCAD
Utility Trench – Type III	April 2009	PDF	Microstation	AutoCAD
Utility Trench Gravel Patch	April 2009	PDF	Microstation	AutoCAD
Wall Details				
Dumpster Screen Wall	April 2009	PDF	Microstation	AutoCAD
Concrete Straight Wall At Planting Area	April 2009	PDF	Microstation	AutoCAD
Retaining Wall W/Stone Face	April 2009	PDF	Microstation	AutoCAD
30" To 56" Retaining Wall Detail	April 2009	PDF	Microstation	AutoCAD
Concrete Seatwall	April 2009	PDF	Microstation	AutoCAD
Retaining Wall Section Detail	April 2009	PDF	Microstation	AutoCAD
Precast Block Wall Detail	April 2009	PDF	Microstation	AutoCAD
Concrete Wall	April 2009	PDF	Microstation	AutoCAD
Underdrain At Walls	April 2009	PDF	Microstation	AutoCAD
Cap & Archway Plaza Walls	April 2009	PDF	Microstation	AutoCAD
Wall Joints	April 2009	PDF	Microstation	AutoCAD
Typ. Jointing & Wall Corners	April 2009	PDF	Microstation	AutoCAD
Screen Wall & Conc. Straight Curb	April 2009	PDF	Microstation	AutoCAD
Water Main Details				
Thrust Block Detail	April 2009	PDF	Microstation	AutoCAD
Water Main Gate Well Detail	April 2009	PDF	Microstation	AutoCAD
Water Main Bore	April 2009	PDF	Microstation	AutoCAD
Water Main Hydrant	April 2009	PDF	Microstation	AutoCAD
Water Main Crossing Detail	April 2009	PDF	Microstation	AutoCAD

Tapwell Detail	April 2009	PDF 	Microstation	AutoCAD
4" – 8" Water Tap Detail	April 2009	PDF 	Microstation	AutoCAD
Temp. Testing Blow-Off	April 2009	PDF 	Microstation	AutoCAD
4" – 8" Water Gate Box	April 2009	PDF 	Microstation	AutoCAD
Site Furnishings Details				
Bench Specifications	June 2010	PDF 		
Bicycle Hoop Detail	April 2009	PDF 	Microstation	AutoCAD
Chair Specifications	June 2010	PDF 		
Memorial Bench Specifications	June 2010	PDF 		
Table Specifications	June 2010	PDF 		
Trash Receptacle Specifications	June 2010	PDF 		

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- MASTER PLANNING
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- SUSTAINABILITY
- SAFETY

- FOR U-M CLIENTS
- FOR VENDORS
- FOR U-M AEC STAFF

OUT TO BID

DESIGN GUIDELINES

CODES & REGULATORY AGENCIES

DESIGN DELIVERABLES

SUSTAINABILITY

SPECIAL INSTRUCTIONS TO DESIGNERS

SPECIAL BUILDING AREAS

OFFICE SPACE

TECHNICAL SECTIONS

STANDARD DETAILS

MASTER SPECIFICATIONS

MASTER SPECIFICATIONS – ARCHITECTURAL

MASTER SPECIFICATIONS – ELECTRICAL

MASTER SPECIFICATIONS – MECHANICAL

PREFERRED MANUFACTURERS

HEALTH SYSTEM PROJECTS

EFFECTIVE DATE

BUILDING COMMISSIONING

CONTRACTS & AGREEMENTS

CONTRACTOR RESOURCES

OTHER LINKS

MASTER SPECIFICATIONS

This section of the U of M Design Guidelines Website contains guide Master Specifications for the design and construction of facilities at the University of Michigan.







The U of M Master Specifications were developed by Architecture and Engineering, for projects designed by

our in-house design staff. They are maintained by roughly the same group that maintains the Design Guidelines Technical Sections. At this time we allow A/Es to use their own master specification, but strongly encourage them to use our Master Specification as a guide. Most sections of the Master Specification require significant editing to tailor them to a specific project. The Master Specifications also include extensive hidden notes to the designer, which should be hidden or deleted prior to printing for bid.

The Master Specification is divided by CSI Division. Mechanical is further divided into individual CSI Sections. Most sections are available in both Acrobat (pdf) and Word (doc) format.

Discipline (CSI Divisions)	Date of Last Revision
Architectural (1-14, 31-32)	May 2014
Mechanical (21-23)	July 2014
Electrical (26-28)	August 2014

There are a few key sections for which we strongly encourage that A/Es use our specification verbatim in lieu of their own. They include:

- [Project Management and Coordination \(Section 013100\)](#) 
- [Full Project Commissioning \(Section 019100\)](#) 
- [Variable Frequency Drives \(Section 220514\)](#) 
- [Mechanical Systems Controls \(Section 230900\)](#) 
- [Unit Substations \(masterspec/Section 261100\)](#) 
- [Fire Detection and Alarm System \(Section 283100\)](#) 

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- SUSTAINABILITY
- SAFETY

- FOR U-M CLIENTS
- FOR VENDORS
- FOR U-M AEC STAFF

OUT TO BID

DESIGN GUIDELINES

CODES & REGULATORY AGENCIES

DESIGN DELIVERABLES

SUSTAINABILITY

SPECIAL INSTRUCTIONS TO DESIGNERS

SPECIAL BUILDING AREAS

OFFICE SPACE

TECHNICAL SECTIONS

STANDARD DETAILS

MASTER SPECIFICATIONS

MASTER SPECIFICATIONS – ARCHITECTURAL

MASTER SPECIFICATIONS – ELECTRICAL

MASTER SPECIFICATIONS – MECHANICAL

PREFERRED MANUFACTURERS

HEALTH SYSTEM PROJECTS

EFFECTIVE DATE

BUILDING COMMISSIONING

CONTRACTS & AGREEMENTS

CONTRACTOR RESOURCES

OTHER LINKS





























MASTER SPECIFICATIONS – ARCHITECTURAL





















































New UM CSI 2012 Sections





















































[Division 01 General Requirements](#)

















Last RevisionReplaces Section

May 2014Division 01

011000 Summary		01100
011400 Work Restrictions		01140
012100 Allowances		01210
012200 Unit Prices		01270
012300 Alternates		01230
012900 Payment Procedures		01290
013100 Project Management And Coordination		01310
013200 Construction Progress Documentation		01320
013300 Submittal Procedures		01330
013500 Special Procedures For BFS Projects		01350
014200 References		01420
015000 Temporary Facilities And Controls		01500
015719 Construction Air Quality		01510
016000 Product Requirements		
017329 Cutting And Patching		01731
017420 Construction and Demolition Waste Tracking		
017700 Closeout Procedures		01770
017823 Operation And Maintenance Manuals		01782
019100 Full Project Commissioning		01715
019110 Project Commissioning For Small Projects		01710
Division 02 Existing Conditions		
024119 Selective Demolition 	 May 2014	02070
028110 Regulated Construction Waste Remediation 	 December 2012	13288
028213 Asbestos Remediation 	 May 2014	13280
028214 Asbestos Remediation – Floor Tile and Mastic 	 May 2014	13281
028215 Asbestos Remediation – Roofing Material 	 May 2014	13282
028300 Lead Remediation 	 May 2014	13285
028333 Lead Remediation – Renovation, Repair and Painting in Child-Occupied Facilities and Target Housing 	 May 2014	13286
028400 PCB Remediation 	 November 2013	13287
Division 03 Concrete		
033053 Miscellaneous Cast-In-Place Concrete 	 December 2012	03301
035416 Hydraulic Cement Underlayment 	 December 2012	03532
Division 04 Masonry		
042000 Unit Masonry 	 December 2012	04810
042010 Unit Masonry Assemblies (Limited Applications) 	 March 2013	04811
Division 05 Metals		
051200 Structural Steel Framing 	 December 2012	05120
053100 Steel Decking 	 December 2012	05310

055000 Metal Fabrications 		December 2012	05500
055800 Formed-Metal Fabrications 		December 2012	05580
Division 06 Woods, Plastics and Composites			
061000 Rough Carpentry 		December 2012	06100
064023 Interior Architectural Woodwork 		December 2012	06400
Division 07 Thermal and Moisture Protection			
075316 Chlorosulfonate-Polyethylene (CSPE) Roofing 		December 2012	07532
075323 Ethylene-Propylene-Diene-Monomer (EPDM) Roofing 		December 2012	07531
078413 Penetration Firestopping 		December 2012	07841
079200 Joint Sealants 		December 2012	07920
Division 08 Openings			
081113 Hollow Metal Doors and Frames 		December 2012	08110
081416 Flush Wood Doors 		December 2012	08211
083113 Access Doors and Frames 		May 2014	08305
083313 Coiling Counter Doors 		December 2012	08336
084113 Aluminum-Framed Entrances and Storefronts 		May 2013	08410
084413 Glazed Aluminum Curtain Walls 		March 2013	08911
085113 Aluminum Windows 		December 2012	08520
087100 Door Hardware 		May 2014	08710
088000 Glazing 		December 2012	08800
088010 Glazing (Interior Applications) 		December 2012	08805
089000 Louvers and Vents 		December 2012	10200
Division 09 Finishes			
092116 Gypsum Board Assemblies 		April 2013	09255
092300 Gypsum Plastering 		December 2012	09210
093000 Tiling 		December 2012	09310
093033 Stone Tiling 		December 2012	09385
095100 Acoustical Ceilings 		May 2014	09510
096466 Wood Athletic Flooring 		April 2013	09644
096500 Resilient Flooring 		April 2013	09650

096723 Resinous Flooring 	 April 2013	09671
096813 Tile Carpeting 	 August 2013	
096816 Sheet Carpeting 	 August 2013	09680
098433 Sound Absorbing Wall Units 	 April 2013	09841
099100 Painting 	 December 2012	09900
099110 Electrostatically Applied Coating 	 December 2012	09925
099310 Wood Floor Finish 	 April 2013	09927
Division 10 Specialties		
101100 Visual Display Units 	 May 2013	10100
101400 Signage 	 December 2012	10425
102113 Toilet Compartments 	 December 2012	10155
102213 Wire Mesh Partitions 	 December 2012	10605
102239 Folding Panel Partitions 	 December 2012	10651
102800 Toilet and Bath Accessories 	 April 2013	10801
104400 Fire Protection Specialties 	 May 2014	10520
105113 Metal Lockers 	 December 2012	10505
Division 11 Equipment		
115213 Projection Screens 	 December 2012	11132
115300 Laboratory Equipment 	 December 2012	11615
115313 Laboratory Fume Hoods 	 December 2013	11610
115314 Fume Hood Refurbishment 	 December 2012	11611
Division 12 Furnishings		
122000 Window Treatment 	 May 2013	12515
122200 Curtains and Drapes 	 December 2012	12490
123553 Laboratory Casework 	 May 2013	12345
124600 Furnishing Accessories 	 December 2012	12575
124813 Entrance Floor Mats and Frames 	 December 2012	12690
Division 13 Special Construction		
132100 Controlled Environment Rooms 	 May 2013	13036
Division 14 Conveying Equipment		
142123 Electric Traction Passenger Elevator 	 December 2012	14210

142423 Hydraulic Passenger Elevator 		December 2012	14240
144200 Wheelchair Lift 		December 2012	14420
146000 Hoists and Cranes 		December 2012	14600
Division 31 Earthwork			
312000 Earth Moving 		December 2012	02300
312323 Fill 		December 2012	02315
312326 Flowable Fill 		December 2012	02310
312500 Erosion and Sedimentation Controls 		December 2012	02215
Division 32 Exterior Improvements			
329210 Lawn Repair 		December 2012	02935

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- HOME
- ABOUT US
- PROJECTS
- MAPS & DETOURS
- MASTER PLANNING
- POLICIES & PROCEDURES
- SUSTAINABILITY
- SAFETY

- FOR U-M CLIENTS
- FOR VENDORS
- FOR U-M AEC STAFF

OUT TO BID

DESIGN GUIDELINES

CODES & REGULATORY AGENCIES

DESIGN DELIVERABLES

SUSTAINABILITY

SPECIAL INSTRUCTIONS TO DESIGNERS

SPECIAL BUILDING AREAS

OFFICE SPACE

TECHNICAL SECTIONS

STANDARD DETAILS

MASTER SPECIFICATIONS

MASTER SPECIFICATIONS – ARCHITECTURAL

MASTER SPECIFICATIONS – ELECTRICAL

MASTER SPECIFICATIONS – MECHANICAL

PREFERRED MANUFACTURERS

HEALTH SYSTEM PROJECTS

EFFECTIVE DATE

BUILDING COMMISSIONING

CONTRACTS & AGREEMENTS

CONTRACTOR RESOURCES

OTHER LINKS

MASTER SPECIFICATIONS – ELECTRICAL











































New UM CSI 2012 Sections

Last Revision

Replaces Section

Division 26 Electrical



260500 Common Work Results for Electrical 		January 2014	16010
260513 Medium, Low & Control Voltage Cables 		August 2014	16120
260526 Grounding & Bonding for Electrical 		December 2012	16450
260533 Electrical Materials & Methods 		December 2013	16050
260543 Underground Services for Electrical Systems 		March 2014	16110
260800 Electrical Acceptance Tests 		August 2013	16950
261000 Medium Voltage Electrical Distribution 		December 2012	16300
261100 Unit Substations 		August 2014	16313 16315 16316
261102 Installation of Pre-Purchased Unit Substations 		December 2012	16314
262000 Low Voltage Electrical Distribution 		August 2013	16400
262726 Wiring Devices 		September 2013	16140
262900 Motor Controls 		August 2013	16480
263000 Engine-Generator System 		December 2013	16231
265100 Interior Lighting 		March 2014	16511
265600 Exterior Lighting 		August 2014	16521
Division 27 Communications			
272000 Voice & Data Communications 		August 2014	19740
275313 Clock Systems 		December 2012	16730
Division 28 Electronic Safety and Security			
281300 Access Control & Monitoring System 		February 2013	16727
281600 Security Systems 		December 2012	16724
283100 Fire Detection and Alarm System 		September 2013	16720 16720AA
283102 Fire Detection and Alarm System (Hospital Projects) 		September 2013	16720-H



- HOME
- ABOUT US
- PROJECTS
- MAPS & DETOURS
- MASTER PLANNING
- POLICIES & PROCEDURES
- SUSTAINABILITY
- SAFETY

- FOR U-M CLIENTS
- FOR VENDORS
- FOR U-M AEC STAFF

OUT TO BID

DESIGN GUIDELINES

CODES & REGULATORY AGENCIES

DESIGN DELIVERABLES

SUSTAINABILITY

SPECIAL INSTRUCTIONS TO DESIGNERS

SPECIAL BUILDING AREAS

OFFICE SPACE

TECHNICAL SECTIONS

STANDARD DETAILS

MASTER SPECIFICATIONS

MASTER SPECIFICATIONS – ARCHITECTURAL

MASTER SPECIFICATIONS – ELECTRICAL

MASTER SPECIFICATIONS – MECHANICAL

PREFERRED MANUFACTURERS

HEALTH SYSTEM PROJECTS

EFFECTIVE DATE

BUILDING COMMISSIONING

CONTRACTS & AGREEMENTS

CONTRACTOR RESOURCES

OTHER LINKS

MASTER SPECIFICATIONS – MECHANICAL

New UM CSI 2012 Sections	Last Revision	Replaces Section
Division 21 Fire Suppression		



211313 Wet-pipe Sprinkler Systems  December 2012 15300

213113 Fire Pumps   December 2012 15320

Division 22 Plumbing

220500 Common Work Results for Mechanical   December 2012 15010

220513 Motors   August 2013 15170


220514 Variable Frequency Drives   January 2013 15960

220516 Pipe Expansion Joints   January 2014 15125


220519 Thermometers, Pressure Gauges & Accessories   January 2014 15130

220523 Valves   February 2014 15100

220533 Heat Tracing for Piping   December 2012 15128


220548 Vibration Control   December 2012 15240

220553 Mechanical Identification   December 2012 15190

220719 Mechanical Systems Insulation   December 2012 15250

221113 Piping Materials & Methods   July 2014 15060

221119 Domestic Water Piping Specialties   January 2014 15411


221123 Domestic Water Booster Pumps   January 2014 15412

221319 Drainage Specialties   December 2012 15420

221333 Packaged Submersible Storm and Sanitary Pumps   December 2012

221500 Compressed Air Accessories   December 2012 15481

223116 Water Softener   January 2014 15455

224200 Plumbing Fixtures   January 2014 15440

226313 Medical Gas Certification (Hospital Projects)   November 2013 15482

Division 23 HVAC

230593 Testing Adjusting & Balancing (TAB)   December 2013 15990

230900 Mechanical Systems Controls   December 2013 15975

230910 Lab Air Flow Controls-DDC   December 2013 15912

230920 Lab Terminal Air Flow Units & Controls   December 2013 15910

230930 Refrigerant Detection & Alarm   December 2012 15635


231113 Fuel Oil Systems   December 2012 15483

231123 Facility Natural Gas Piping   December 2012 15488

232116 Hydronic Piping Specialties   December 2012 15515

232123 Plumbing and Hydronic Pumps   January 2014 15160


232216 Steam & Condensate Piping Specialties   December 2012 15525


232300 Refrigerant Piping   December 2012 15530

232513 Chemical Water Treatment – Closed Loop   March 2013 15189

232516 – Chemical Water Treatment – Open Loop Systems   October 2013

















232519 Steam Boiler Chemical Water Treatment   December 2012 15188

233100 HVAC Ducts & Casings   February 2013 15890

233300 Air Duct Accessories & RGDs   February 2013 15895

233400 Fans   October 2013 15870

233600 Air Terminal Units   June 2013 15896

234000 HVAC Air Cleaning Devices 	 December 2012	15885
235100 Breechings, Chimneys & Stacks 	 December 2012	15575
235239 Fire Tube Boilers (Hot Water) 	 December 2012	15557
235240 Fire Tube Boilers (Steam) 	 December 2012	15558
235300 Heating Boiler Feed Water & Blow-down Equip 	 December 2012	15559
235719 Plate Type Liquid to Liquid Heat Exchanger 	 January 2014	
236416 Centrifugal Water Chillers 	 February 2013	15684
236500 Cooling Towers 	 March 2013	15710
237213 Rotary Air-to-Air Energy Recovery Wheels 	 January 2013	
237323 Custom Air Handling Units 	 July 2013	15854
237324 Semi-Custom Air Handling Units 	 March 2013	15855
238216 Coils and Drain Pans 	 December 2012	15820
238219 Floor Mounted Fan Coil Units (Un-ducted) 	 December 2012	15763
238220 Horizontal Fan Coil Units 	 December 2012	15764
238221 Blower Coil Units 	 December 2012	15765
238413 Steam Humidifiers 	 December 2012	15810

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- MASTER PLANNING
- POLICIES & PROCEDURES
- SUSTAINABILITY
- SAFETY

- FOR U-M CLIENTS
- FOR VENDORS
- FOR U-M AEC STAFF

OUT TO BID

DESIGN GUIDELINES

CODES & REGULATORY AGENCIES

DESIGN DELIVERABLES

SUSTAINABILITY

SPECIAL INSTRUCTIONS TO DESIGNERS

SPECIAL BUILDING AREAS

OFFICE SPACE

TECHNICAL SECTIONS

STANDARD DETAILS

MASTER SPECIFICATIONS

PREFERRED MANUFACTURERS

HEALTH SYSTEM PROJECTS

EFFECTIVE DATE

BUILDING COMMISSIONING

CONTRACTS & AGREEMENTS

CONTRACTOR RESOURCES

OTHER LINKS

PREFERRED MANUFACTURERS

Preferred List of Manufacturers contains specific manufacturers that are acceptable for use on U of M projects
This section is also divided by CSI number.

[Preferred Manufacturers List General Procedures](#)

DISCIPLINE

DATE OF LAST UPDATE

[Architectural \(Divisions 1 through 14\)](#)

May 2013

[Mechanical \(Division 15\)](#) 

April 2014

[Electrical \(Div 26, 27, 28\)](#) 

February 2014

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ARCHITECTURAL PREFERRED MANUFACTURERS LIST

General

This list is a compilation of products approved for use on University of Michigan projects. Where specific manufacturers or products are listed for a given building element, limit selection to the products listed. When, in your opinion, an unlisted product should be considered for inclusion in a project, consult with the Design Manager. Do not substitute this list for your professional judgment concerning appropriate products and materials.

Where specific products are not listed for a given building element (i.e. curtain walls), base the selection of manufacturers, types, styles, or models on your professional judgment. Wherever possible, select the products of at least 3 manufacturers. Avoid the use of open ended "or equal" statements.

This list is updated as needed.

Table of Contents

Section 075316	Chlorosulfonate-Polyethylene (CSPE) Roofing
Section 075323	Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
Division 8	Aluminum Fluoropolymer Coatings
Section 084113	Aluminum Framed Entrances and Storefronts
Section 084413	Glazed Aluminum Curtain Wall
Section 085113	Aluminum Windows
Section 087100	Door Hardware
Section 088000	Glazing
Section 101100	Visual Display Units
Section 102113	Toilet Compartments
Section 102800	Toilet and Bath Accessories
Section 115313	Laboratory Fume Hoods
Section 123553	Laboratory Casework
Section 122000	Window Treatment
Section 132100	Controlled Environment Rooms

Preferred Manufacturers

Section 075316 - Chlorosulfonate-Polyethylene (CSPE) Roofing

- Carlisle SynTec Systems
- Stevens Roofing Systems, Dow Building Solutions.

Section 075323 - Ethylene-Propylene-Diene-Monomer (EPDM)

EPDM Systems:

- Carlisle SynTec Systems, Carlisle Corporation
- Firestone RubberGard EPDM Roofing Systems, Firestone Building Products Co.
- Genflex Roofing Systems, GenCorp. Polymer Products, Building Systems Div.
- Johns Manville Roofing Systems, Johns Manville Corp.
- Versiguard Roofing Systems, Versico Incorporated.

Division 8 (applies to sections 08410, 08520, 08911) - Aluminum Fluoropolymer Coatings

- PPG Industries.
- Valspar Corp.
- Akzo Nobel.

Section 084113 - Aluminum Framed Entrances and Storefronts

Entrances, Doors and Storefront Systems:

- EFCO Corp., a Pella company.
- Kawneer North America; an Alcoa company
- Oldcastle Building Envelope.
- Tubelite Company, Inc.
- Wausau Window and Wall Systems

Flush Panel FRP Doors (Doors only, not framing):

- Commercial Door Systems
- Kawneer North America; an Alcoa companyRebco, Inc.
- Special-Lite, Inc.

Section 084413 - Glazed Aluminum Curtain Wall

- EFCO, Corp.; a Pella company.
- Graham Architectural Products
- Harmon, Inc.
- Kawneer North America; an Alcoa company.
- Oldcastle BuildingEnvelope.
- Wausau Window and Wall Systems.

Section 085113 - Aluminum Windows

Architectural Grade Windows (subject to availability of project-applicable products):

- Graham Architectural Products
- Kawneer North America; an Alcoa company.
- Wausau Window and Wall Systems.

Section 087100 - Door Hardware

Butt Hinges:

- Hager Companies
- Ives, Ingersoll Rand.
- McKinney Products Company
- Stanley

Continuous Geared Hinges:

- Hager Companies
- Pemko
- Select Products Limited

Locksets (mechanical and electrified):

- Corbin Russwin ML2200
- Sargent 8200 Series
- Schlage L Series

Electric Strike:

- Von Duprin 6000 Series
- HES 1006, 9400 and 9600 Series

Small Format Interchangeable Cores (SFIC):

In existing buildings, match existing core type for ease of keying.

- Best Access Systems
- Medeco Keymark
- Schlage Everest

Exit Devices (mechanical and electrified):

- Sargent
- Von Duprin

Digital Locks (Standalone battery operated, not connected to campus access control system):

- Schlage only
 - Non-programmable keypad type: CO-100-MS-70-KP
 - Programmable keypad type: CO-200-MS-70-KP
 - Programmable mag stripe card reader: CO-200-MS-70-MS

Closers:

- LCN 4000 Series only

Overhead Holders and Stops:

- Glynn Johnson 410 Series
- Rixson 6 Series
- Rockwood 14000 Series

Local Exit Alarms (not connected to fire alarm or campus access control systems):

- Detex

Flush Bolts (Automatic, Constant Latching and Manual):

- Door Controls International (DCI)
- Ives
- Rockwood

Flatgoods: Any BHMA member

Weatherstripping/Thresholds: Any BHMA member

Concealed Power Transfer:

- Securitron
- Von Duprin

Section 088000 - Glazing

Primary Glass:

- AGC Flat Glass North America
- Guardian Industries Corp.
- Pilkington North America, Inc.
- PPG Industries, Inc.

Laminated Glass:

- AGC Flat Glass North America
- Guardian Industries Corp.
- Oldcastle Glass Group.
- Viracon, Inc.

Insulating Glass Units:

- AGC Flat Glass North America
- Guardian Industries Corp.
- Oldcastle Glass Group.
- Viracon, Inc.

Fire-Rated Glazing:

- AGC Glass Company.
- Nippon Electric Glass Co., Ltd.
- Pilkington Group, Pyrostop.
- Vetrotech Saint-Gobain USA.

Section 101100 - Visual Display Units

Markers and Chalkboards:

- Cig Jan Products, Ltd.
- Claridge Products, Inc.
- Marsh Industries, Inc.
- PolyVision Corp.

Section 102113 - Toilet Compartments

- All American Metal Corp.
- Bradley Corporation; Mills Partitions.
- Flush-Metal Partitions LLC.
- Hadrian Manufacturing, Inc.

Section 102800 - Toilet and Bath Accessories

- American Specialties, Inc. (ASI).
- Bobrick Washroom Equipment, Inc.
- Bradley Corp.
- Elcoma Metal Fabricating (grab bars and shower seats only).
- Gamco, a division of Bobrick Washroom Equipment (except for shower seats and counter mounted soap dispensers).
- Koala Kare Products (baby changing stations only), a division of Bobrick Washroom Equipment.

Note: Toilet paper dispensers, paper towel dispensers (roll-type), and wall mounted soap dispensers are provided by UM, but installed by the Contractor. Coordinate with Design Manager.

Section 115313 - Laboratory Chemical Fume Hoods

Chemical Fume Hoods: All types except reduced face velocity

- Air Master Systems Corp.
- BMC Laboratory Cabinets & Fume Hoods
- Thermo Fisher Scientific Hamilton
- Kewaunee Scientific Corp.
- Labconco Corp.
- Mott Manufacturing Ltd.
- Lab Crafters, Inc.

Chemical Fume Hoods: Reduced face velocity

- Kewaunee Scientific Corp.; Supreme Air LV
- Lab Crafters, Inc.; Air Sentry
- Labconco Corp. ; Protector XStream

Base Cabinets for Fume Hoods: Refer to approved laboratory casework manufacturers list.

Section 123553 - Laboratory Casework

Metal Casework; associated distributors:

- Air Master Systems Corp.
- BMC Laboratory Cabinets & Fume Hoods,; RD Landstra Associates.
- Kewaunee Scientific Equip. Corp.; Farnell Equipment Co.
- Laboratory Design & Supply, Inc.
- Mott Manufacturing, Ltd.; Detroit Technical Equipment Company

Flammable Storage: Produced in accordance with NFPA 30 and FM or UL labeled.

Wood Casework; associated distributors:

- Kewaunee Scientific Equip. Corp.; Farnell Equipment Co.
- Laboratory Design & Supply, Inc. (Flush overlay only; lipped overlay not available)
- Mid Canada Millwork
- Mott Manufacturing, Ltd.; Detroit Technical Equipment Company
- Conditional Approval: The following manufacturers are new to the PML and are approved for use on small projects (estimated casework cost less than \$100,000):
 - CIFLab L-Line (lipped overlay) and E-line (full overlay); Stonecreek Interior Systems, LLC
 - Diversified Casework; RD Landstra Associates.
 - Wood-Metal Industries; Divisions of Wood-Mode; Farnell Contracting

Epoxy Resin Tops and Sinks:

- Kemresin (Kewaunee Scientific Corp.)
- Durcon, Inc.
- Epoxyn; Epoxyn Products

Stainless Steel Sinks and Tops:

- Elkay Co.
- Just Manufacturing

Fiberglass Sinks:

- Kreolab, Inc.

Shelf Standards and Brackets:

- Cooper B-Line, Inc.
- Flex-Strut, Inc.
- Kewaunee Scientific Equip. Corp.
- Nu-Strut framing channel system, Kumar Industries, Inc.
- Unistrut Corp.

Service Fittings:

- Chicago Faucets, a Geberit Company.
- T & S Brass and Bronze Works, Inc.
- Watersaver Faucet Company
- Wolverine Brass, Inc.

Section 122000 - Window Treatment

Review specific window treatment requirements with Design Manager. Small renovation projects will typically match established building standard. New buildings and major renovations will select window treatments based on performance requirements, including solar transmission and thermal properties.

Aluminum Horizontal Blinds

- Levolor Window Fashions
- Hunter Douglas
- Springs Window Fashions; Bali

Roller Shade Hardware:

- Springs Window Fashions; Bali
- Draper Inc.; Flexshade
- OpenLight
- MechoShade Systems, Inc.
- Roll Ease, Skyline Series
- SRF Enterprises, Inc.

Shade Fabric: Tested in accordance with NFPA 701.

Section 132100 – Controlled Environment Rooms

Environmental Rooms:

- Bahnson Environmental Specialties, an EMCOR company
- Environmental Growth Chambers
- Harris Environmental Systems, Inc.
- Insulated-Structures, Ltd.
- Nor-Lake, Inc.



ELECTRICAL TRADES **PREFERRED MANUFACTURERS LIST**

Scope

The Electrical Trades Preferred Manufacturers List identifies manufacturers and suppliers who are known to provide good quality products, meet specification and schedule requirements, provide technical support, and provide service after the sales. This list is intended to regulate product quality, standardize electrical designs, and simplify maintenance activities. It is not intended to limit competition. It is not all inclusive. It is a list of manufacturers whose products are well known to the University due to their frequent and successful use.

This List shall be used by A/E's when selecting manufacturers for specification in electrical designs. **A/E'S SHALL SPECIFY ONLY THE LISTED MANUFACTURERS THAT MEET THEIR PROJECT'S REQUIREMENTS, AND SHOULD SPECIFY A MINIMUM OF THREE MANUFACTURERS WHENEVER POSSIBLE.** A/E's may specify manufacturers not on this list to satisfy project requirements, **BUT ONLY AFTER OBTAINING UNIVERSITY APPROVAL IN ADVANCE.**

This List shall **NOT** be used by Contractors to justify making substitutions for products specified in the construction documents. **CONTRACTORS SHALL PROVIDE THE PRODUCTS SPECIFIED IN THE CONSTRUCTION DOCUMENTS UNLESS THE UNIVERSITY APPROVES THEIR PROPOSED SUBSTITUTIONS AT THE TIME OF BID IN ACCORDANCE WITH THE PROJECT'S STANDARD GENERAL CONDITIONS.**

THIS LIST DOES NOT APPLY to purchases by the University Plant Department of replacement electrical products required to match or maintain existing installations.

This List is revised as needed. Before using it, check the AEC Website for the latest revision.

<u>TABLE OF CONTENTS</u>	<u>PAGE</u>
SECTION 260513 - MEDIUM, LOW & CONTROL VOLTAGE CABLES.....	2
SECTION 260526 - GROUNDING & BONDING FOR ELECTRICAL.....	2
SECTION 260533 - ELECTRICAL MATERIALS AND METHODS	3
SECTION 260543 - UNDERGROUND SERVICES FOR ELECTRICAL.....	4
SECTION 260800 - ELECTRICAL ACCEPTANCE TESTS	4
SECTION 261100 - UNIT SUBSTATIONS.....	5
SECTION 262000 - LOW VOLTAGE ELECTRICAL DISTRIBUTION	7
SECTION 262726 - WIRING DEVICES	8
SECTION 262900 - MOTOR CONTROLS.....	9
SECTION 263000 - ENGINE-GENERATOR SYSTEMS.....	10
SECTION 263300 - BATTERY EQUIPMENT.....	10
SECTION 264100 - FACILITY LIGHTNING PROTECTION	11
SECTION 265100 - INTERIOR LIGHTING.....	11
SECTION 265600 - EXTERIOR LIGHTING	13
SECTION 274000 - AUDIO-VIDEO SYSTEMS.....	14
SECTION 275116 - PUBLIC ADDRESS & MASS NOTIFICATION SYSTEMS	14
SECTION 275126 - ASSISTIVE LISTENING SYSTEM.....	14
SECTION 275313 - CLOCK SYSTEMS.....	14
SECTION 281300 - ACCESS CONTROL & MONITORING SYSTEMS.....	14
SECTION 281600 - SECURITY SYSTEMS.....	15
SECTION 283100 - FIRE DETECTION & ALARM SYSTEMS.....	15

SECTION 260513 - MEDIUM, LOW & CONTROL VOLTAGE CABLES

Cables (Medium Voltage)

- General Cable
- Kerite
- Okonite
- Prysmian

Cables and Wire (600 Volts)

- Aetna Wire and Cable
- Alan Wire
- American Insulated Wire
- Cerro Wire
- Encore
- General Cable
- Republic Wire
- Rockbestos-Surprenant
- Service Wire
- Southwire
- United Copper Industries

MC Cables (600 Volts)

- AFC
- Encore
- Kaf-Tech
- Rockbestos-Surprenant
- Service Wire
- Southwire
- United Copper Industries

2-Hour Fire Rated Cables (600 Volts)

- Pyrotex Mineral Insulated (Type MI) by Pentair

Control Cables and Wire

- Belden
- Coleman

Cable Splices for Medium Voltage Cable

- Raychem

Cable Terminations for Medium Voltage Cable

- Raychem

SECTION 260526 - GROUNDING & BONDING FOR ELECTRICAL

Ground Connections

- Burndy Hyground (Proper dies must be used)
- Cadweld
- Thermoweld
- Thomas & Betts Blackburn (Above grade only)

SECTION 260533 - ELECTRICAL MATERIALS AND METHODS

Cable Trays - Center Spline and Wall Mount Types (Use only where ladder and wire basket trays cannot be used, and only with ITCS (Campus projects) or MCIT (UMHHC projects) approval)

- B-Line
- Legrand/Wiremold
- Mono-Systems
- Thomas & Betts

Cable Trays - Ladder Type

- B-Line
- Chalfant
- Cope
- Globetrax (GS Metals)
- Husky
- Legrand Cablofil
- Mono-Systems
- Thomas & Betts

Cable Trays – Wire Basket Type (Use only with ITCS (Campus projects) or MCIT (UMHHC projects) approval)

- B-Line
- Chalfant
- Legrand Cablofil EZTray
- Mono-Systems

Conduits, Raceways and Accessories

EMT, liquid-tight flexible metallic conduit, and/or non-liquid-tight flexible metallic conduit/raceway; plus associated accessories, fittings, junction and pull boxes, and related products

Products of all manufacturers are acceptable as long as they are electro-galvanized steel, have a smooth interior, and are NRTL labeled for the application.

Rigid (galvanized metal), and IMC (intermediate metal) conduits/raceway, plus associated accessories, fittings, junction and pull boxes, and related products

Products of all manufacturers are acceptable, as long as they are hot-dipped galvanized steel inside and out, have a smooth interior, and are NRTL labeled for the application. Boxes shall be cast, not formed. IMC may only be used when tools specifically designed for IMC are used.

PVC conduit/raceway (Type DB, Schedule 40, and Schedule 80), plus associated accessories, fittings, junction and pull boxes, and related products

Products of all manufacturers are acceptable as long as they are sunlight resistant, and NRTL labeled for the application. Products from manufacturers making both the conduit and the fittings are preferred whenever possible.

Fiberglass Reinforced Epoxy (FRE) conduit/raceways, accessories, fittings, and related products

- FRE
- Champion

Cord Reels

Appleton
Hubbell
Reel-O-Matic Systems
Woodhead

Electrical Enclosures

Carlson (For use with PVC raceways)
Hammond
Hoffman
Park Metal
Rittal

Fire Stop Compounds

A. D. Fire Protection Systems
Flame Safe
Hilti
Nelson
STI SpecSeal
3M Company

Structural Support Materials

Aickinstrut (Fiberglass)
B-Line
Champion (Fiberglass)
Hilti
Powerstrut
Unistrut

Surface and Underfloor Wireways

Carlson
Hubbell
Legrand Evolution Floor Boxes
Legrand (Wiremold)
Mono-Systems
Panduit

SECTION 260543 - UNDERGROUND SERVICES FOR ELECTRICAL**Underground Hand Holes, Junction Boxes and Pull Boxes**

CDR Systems
Carson-Brooks
Quazite

SECTION 260800 - ELECTRICAL ACCEPTANCE TESTS**Nationally Recognized Testing Laboratory Services**

CSA
ETL
MET Laboratories
UL (Northbrook, IL)

Testing Services

Bisbee Infrared Services (Penny Wilson, (517) 787-4620)
Northern Electrical Testing (Lyle Detterman, (810) 689-8980)
Utilities Instrumentation Services (David Wheeler, (734) 482-1450)

SECTION 261100 - UNIT SUBSTATIONS**Non-Current Limiting Fuses (Primary)**

S & C Type SM-5SS (With high interrupting capacity adapter)
Eaton/Cutler-Hammer Type RBA-400 (With high interrupting capacity adapter)

Current Limiting Fuses (Primary)

Ferraz-Shawmut, Type CL-14
Eaton/Cutler-Hammer Type CLE
General Electric Type EJO

KWHR/Demand Meters

Power Measurement Limited (PML) 7330 ION (With options per Master Spec 16313)

15 kV Fused and Unfused Primary Switches (5kV rated switches may only be used for 5 kV (4,160 volt) class motors)

Eaton/Cutler-Hammer
Powercon
Square D

15kV Metal Clad Switchgear and/or Circuit Breakers (5kv rated circuit breakers may only be used for 5 kV (4,160 volt) class motors)

Eaton/Cutler-Hammer
General Electric
Square D

Circuit Breakers for 600-volt Class Secondary Switchgears and Switchboards

Asea Brown Boveri
Eaton/Cutler-Hammer
General Electric
Square D

Transformers

Asea Brown Boveri
Eaton/Cutler-Hammer
General Electric
MGM
Olsun
Square D

Substation Assemblers (Using components from Preferred Manufacturers only)

Controlled Power Corporation
Eaton/Cutler-Hammer
Electrical Product Sales
General Electric
Park Metal
Powercon
Pederson Power Products
Shallbetter
Square D

Addresses of above Assemblers

Controlled Power Corporation
295 Wetmore Ave SE
Massillon, Ohio 44646
Phone: 800 321 0414
FAX: 330 834 3201

Eaton/Cutler-Hammer
McNaughton-McKay Electric Co.
4670 Runway Blvd, Ann Arbor, MI 48108
Phone: 734-327-6251
Fax: 734-327-6285

Eaton/Cutler-Hammer
Service Electric Supply Co.
15424 Oakwood Drive, Romulus, MI 48174
Phone: 734-229-9100
Fax: 734-229-9101

Electrical Product Sales
Dick Stone
(248) 583-6100

General Electric
McNaughton-McKay Electric Co.
4670 Runway Blvd, Ann Arbor, MI 48108
Phone: 734-327-6251
Fax: 734-327-6285

Olsun Electrics
HEK Inc.
6083 Lafayette
Ann Arbor, MI 48103
Phone: (734) 995-0900

Park Metal
19197 Sherwood Street, Detroit, MI 48234
Phone: 313-366-2200
Fax: 313-366-1540

Powercon/Woodlyn Sales
9357 General Drive - Suite 102, Plymouth, MI 48170
Phone: 734-453-2754
Fax: 734-453-2759

Pederson Power Products
1521 Eden Gardens Drive, Fenton, MI 48430
Phone: 810-750-3032
Fax: 810-750-9557

Square D
Madison Electric Co.
3900 Jackson Rd, Ann Arbor, MI 48106
Phone: 734-665-6131
Fax: 734-665-9239

Square D
Wyandotte Electric Supply Co.
212 S. Wagner Rd, Ann Arbor, MI 48103
Phone: 734-769-6400
Fax: 734-769-7745

SECTION 262000 - LOW VOLTAGE ELECTRICAL DISTRIBUTION

Bus Ducts

Eaton/Cutler-Hammer
General Electric
Siemens
Square D

Fuses (600 Volts and Below)

Bussmann
Ferraz-Shawmut
Littelfuse

Surge Protective Devices

Current Technology
Eaton/Cutler-Hammer-Tycor
Intermatic (For protection of individual loads and receptacle panels only)
L.E.A. Dynatech
Leviton (For protection of individual loads and receptacle panels only)
Liebert
Square D

Switchboards, Panelboards and Circuit Breakers

Eaton/Cutler-Hammer (Only with U of M Lugs - confirm on shop drawings)
General Electric
Industrial Electrical Manufacturing (For custom and retrofit applications only)
Siemens
Square D

Time Switches

Intermatic
Paragon
Sangamo
Tork

Transformers (Liquid Filled and Dry Pad-Mounted Type)

Eaton/Cutler-Hammer
General Electric
Olsun Electrics
Pennsylvania
Pioneer

Transformers (Distribution Dry Type)

Acme
Eaton/Cutler-Hammer
General Electric
Hammond Power Systems
Hevi-Duty
MGM
Olsun Electrics
Siemens
Square D

SECTION 262726 - WIRING DEVICES**Dimmer Switches**

Leviton (Incandescent type only)
Lithonia (Incandescent and fluorescent types)
Lutron (Incandescent and fluorescent types)

Occupancy Sensors (Infrared, Ultrasonic, Combination Infrared/Microphonic Dual Technology and Combination Infrared/Ultrasonic Dual Technology)

Hubbell
Leviton
Lutron
Sensor Switch
Tork
Watt Stopper

Pin & Sleeve Connectors

Crouse-Hinds
Hubbell
Killark
Leviton
Pass & Seymour

Power Poles

Hubbell
Mono-Systems
Steelcase
Wiremold

120-volt, 20-ampere Receptacles (GFCI, Hospital Grade, TVSS & Child Resistant)

Bryant
Cooper (Arrow Hart)
Hubbell
Leviton
Pass & Seymour

120-volt, 20-ampere Receptacles and Plugs

Bryant
Arrow Hart (Cooper)
Hubbell
Leviton
Pass & Seymour

Special Power Receptacles and Plugs

Bryant
Arrow Hart (Cooper)
Hubbell
Leviton
Pass & Seymour

USB Charging Port Receptacles

Leviton

120/277 Volt, 20-Ampere Light Switches

Bryant
Arrow Hart (Cooper)
Hubbell
Leviton
Pass & Seymour

SECTION 262900 - MOTOR CONTROLS**Capacitors for Power Factor Correction**

Aerovox
Eaton/Cutler-Hammer
General Electric
Myron Zucker
Siemens
Square D

Motor Controls (MCC's, Starters, Contactors, Disc. Switches and Control Devices

Allen-Bradley
Eaton/Cutler-Hammer
General Electric
Siemens
Square D

Motor Starters (Electronic Soft Starter Type)

Allen-Bradley
Eaton/Cutler-Hammer
Sprecher & Schuh

SECTION 263000 - ENGINE-GENERATOR SYSTEMS**Natural Gas Fired Engine-Generator Sets (Only those which require inlet gas pressures of 14 inches of water column or less)**

Caterpillar
Cummins
Generac Industrial Power (up through 300 kW)
Kohler
Olympian

Automatic and Manual Transfer Switches (Open and Closed Transition Types)

ASCO
Cummins
Eaton/Cutler-Hammer
GE Zenith Controls
Kohler

Automatic Transfer Switches (Soft-Loading Type)

ASCO
Eaton/Cutler-Hammer
Kohler

Resistive Load Banks

Avtron
Sephco
Simplex

SECTION 263300 - BATTERY EQUIPMENT**Batteries**

C & D Technologies
Chloride Plante
Energysys
Johnson Controls

Battery Chargers

LaMarche
SCI
Energysys
C & D Technologies
Hi-Tran

Uninterruptible Power Supply Systems (Battery type)

A.P.C.
Best (Individual small load units only)
Controlled Power
Liebert
MGE
Mitsubishi (Totally solid-state)
Toshiba

Rotary UPS Systems

Designed Power Solutions International (DPSI)

SECTION 264100 - FACILITY LIGHTNING PROTECTION**Lightning Protection Services**

Guardian Equipment, Novi, MI (248) 449-5200
Michigan Lightning Protection, Grand Rapids, MI (616) 453-1174
Orion Services, Wixom, MI (248) 624-2120
Sleeping Bear Lightning Protection, Maple City, MI (231) 228-4112

SECTION 265100 - INTERIOR LIGHTING**Ballasts (Electronic Compact Fluorescent)**

Advance Smart Mate
Aculite
Lightolier
Prescolite

Ballasts (Electronic Rapid Start T-8 Fluorescent)

Advance Optanium
Bodine (For emergency lighting only)
Osram/Sylvania Quicktronic Professional
Universal AccuStart

Ballasts (Electronic Dimming T-8 Fluorescent)

Advance Mark X (5% dimming type)
Lightolier (1% dimming type)
Osram/Sylvania (10% dimming type)

Emergency Power Ballasts (Electronic Rapid Start T-8 Fluorescent)

Bodine (For emergency lighting only)
Lithonia

Ballasts (H.I.D.)

Advance
MagneTek
Universal

Dimming Systems

AMX
Crestron Electronic, Inc.
E.T.C.
Lithonia
Strand (Stage lighting only)
Leviton (Small single room systems only)
Lutron

Emergency Lights

Chloride
Dual-Lite
Emergi-Lite
Exide Lightguard
Lightalarms
Lithonia
Sure-Lite

Exit Signs (LED)

Chloride
Dual-Lite
Emergi-Lite
Exide Lightguard
Lightalarms
Lithonia
LSI Industries
Morlite (High abuse areas) (Philips)
Prescolite
Sure-Lites

Lamps

General Electric Ecolux
Philips Alto
Osram/Sylvania Ecologic
Venture (H.I.D. only)

Lighting Fixtures (Fluorescent)

Alkco (Philips)
Bartco
Columbia
Day-Brite (Philips)
Fail-Safe (Cooper)
Finelite
Focal Point
Guth (Philips)
Harris
Holophane (Acuity)
Hubbell
Keene
Kenall

Kirlin
Lightolier (Philips)
Linear Lighting
Lithonia (Acuity)
LSI Industries
Cooper (Metalux)
Peerless (Acuity)
Prudential
Quality (Philips)
Visa
Williams
Zumtobel

Lighting Fixtures (H.I.D.)

Best	Hubbell
Crouse-Hinds (Cooper)	Kenall
Day-Brite (Philips)	Lightolier (Philips)
Fail-safe (Cooper)	Lithonia (Acuity)
General Electric	LSI Industries
Guth (Philips)	Lumark (Cooper)
Harris	McGill
Holophane	Quality (Philips)
	SPI

Lighting Fixtures (Compact Fluorescent and Incandescent)

Globe	Lightolier (Philips)
Gotham (Acuity)	Lithonia (Acuity)
Halo	LSI Industries
Harris	Omega (Philips)
Kenall	Prescolite (Hubbell)
Kirlin	Quality (Philips)
	Swivelier

Lighting Fixtures (LED)

CREE
Man-D-Tec (Elevator cab and space lighting)

SECTION 265600 - EXTERIOR LIGHTING**Lighting Fixtures (Outdoor Building, Parking Lot and Roadway with poles by fixture supplier)**

BEGA (Conditional Approval)
Gardco
Holophane
Kim (Hubbell) (Conditional Approval)
Lithonia Hi-Tek
LSI Industries
Lumecon
McGraw-Edison
Stern
Wide-Lite (Philips)

Lighting Fixtures (Outdoor Pedestrian Area with poles by fixture supplier)

Lumec

Photoelectric Lighting Controls

Crouse-Hinds
Holophane
Hubbell
Intermatic
Tork

SECTION 274000 - AUDIO-VIDEO SYSTEMS

Wireless Microphone Systems

Shure

SECTION 275116 - PUBLIC ADDRESS & MASS NOTIFICATION SYSTEMS

Public Announcement and Sound Systems

Aiphone Communications Systems

Atlas/Soundolier

Dukane

Rauland-Borg

SECTION 275126 - ASSISTIVE LISTENING SYSTEM

Hearing Assistance Systems

Phonic Ear (for classroom applications)

Sound Associates (for auditorium and theater applications)

SECTION 275313 - CLOCK SYSTEMS

Central Clock Systems

Primex (GPS synchronous wireless)

Simplex Time Recorder (through Simplex/Grinnell)

Clocks (Battery Powered)

Edwards

Franklin

Howard Miller

Primex (GPS synchronous wireless)

SECTION 281300 - ACCESS CONTROL & MONITORING SYSTEMS

Card Access Control Systems

Software House (for Campus buildings)

Diebold/CBORD (for Housing facilities)

Card Access Control System Designers/Installers

Siemens (Mike Atzenhofer, 734 456-3800)

Cabling Concepts (Tim Grady, 248 363-4200)

TTI (John Rademaker, 586 864-1110)

Simplex/Grinnell (John Keith, 248 427-5050)

Electronic Security Systems, Inc. (Steven Maniaci, 586 756-8400)

Johnson Controls

SECTION 281600 - SECURITY SYSTEMS

Closed Circuit TV Systems

Diamond Electric
Panasonic
Sensormatic
Vicon Industries

Security Systems

ADT Security Systems
Faraday
Radionics (For small systems only)
Simplex Time Recorder

SECTION 283100 - FIRE DETECTION & ALARM SYSTEMS

Fire Alarm Systems

EST (through Riverside Integrated Systems only)
Honeywell (UMHHC only)
Simplex Time Recorder (through Simplex/Grinnell)
Vesda (For smoke sampling systems only)

MECHANICAL TRADES
PREFERRED MANUFACTURERS LIST

April 2014

INDEX OF MECHANICAL SECTIONS:

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS (15300)
SECTION 213113 - FIRE PUMPS (15320)
SECTION 220000 - UNDERGROUND PIPING IN CONDUIT SYSTEM
SECTION 220500 - COMMON WORK RESULTS FOR MECHANICAL (15010)
SECTION 220513 - MOTORS (15170)
SECTION 220514 - VARIABLE FREQUENCY DRIVES (15960)
SECTION 220516 - PIPE EXPANSION JOINTS (15125)
SECTION 220519 - THERMOMETERS, PRESURE GAUGES & ACC'S (15130)
SECTION 220523 - VALVES (15100)
SECTION 220533 - HEAT TRACING FOR PIPING (15128)
SECTION 220548 - VIBRATION CONTROL (15240)
SECTION 220553 - MECHANICAL IDENTIFICATIONS (15190)
SECTION 220719 - MECHANICAL SYSTEMS INSULATION (15250)
SECTION 221113 - PIPING MATERIALS & METHODS (15060)
SECTION 221119 - DOMESTIC WATER PIPING SPECIALITIES (15411)
SECTION 221319 - DRAINAGE SPECIALITIES (15420)
SECTION 221500 - COMPRESSED AIR ACCESSORIES (15481)
SECTION 223116 - WATER SOFTENER (15455)
SECTION 224200 - PLUMBING FIXTURES (15440)
SECTION 230000 - AIR COOLED CONDENSING UNITS
SECTION 230000 - AIR COOLED PACKAGED CHILLERS
SECTION 230000 - CAST IRON BOILERS
SECTION 230000 - DUCTLESS SPLIT ROOM AIR CONDITIONERS- AIR COOL
SECTION 230000 - HEAT EXCHANGERS & CONVERTERS
SECTION 230000 - HUMIDIFIERS
SECTION 230000 - HVAC WATER TREATMENT
SECTION 230000 - MULTIMEDIA FILTRATION SYSTEMS MS NOT ON WEBSITE
SECTION 230000 - PACKAGED COMPUTER ROOM AIR CONDITIONING SYSTEM
SECTION 230000 - PACKAGED HEAT TRANSFER UNITS
SECTION 230000 - PACKAGED TERMINAL AIR CONDITIONERS, AIR-COOLED
SECTION 230000 - STEAM ABSORPTION CHILLER
SECTION 230000 - STEAM CONDENSATE RETURN UNITS
SECTION 230000 - TERMINAL UNITS
SECTION 230593 - TESTING, ADJUSTING AND BALANCING (15990)
SECTION 230900 - MECHANICAL SYSTEMS CONTROLS (15975)
SECTION 230920 - LABORATORY TERMINAL AIR FLOW UNITS & CONTROL (15910)
SECTION 230930 - REFRIGERANT DETECTION AND ALARM (15635)
SECTION 231123 - FACILITY NATURAL GAS PIPING (15488)
SECTION 232116 - HYDRONIC PIPING SPECIALTIES (15515)
SECTION 232123 - PLUMBING AND HYDRONIC PUMPS (INCLUDES VACUUM PUMPS) (15160)
SECTION 232216 - STEAM & CONDENSATE PIPING SPECIALTIES (15525)
SECTION 232300 - REFRIGERANT PIPING (15530)
SECTION 232519 - STEAM BOILER CHEMICAL WATER TREATMENT (15188)
SECTION 233100 - HVAC DUCTS & CASINGS (15890)
SECTION 233300 - AIR DUCT ACCESSORIES & RGDS (158950)
SECTION 233400 - FANS (15870)
SECTION 233600 - AIR TERMINAL UNITS (15896)
SECTION 234000 - HVAC AIR CLEANING DEVICES (15885)
SECTION 235100 - BREECHINGS, CHIMNEYS & STACKS (15575)
SECTION 235239 - FIRE TUBE BOILERS (HOT WATER) (15557)
SECTION 235240 - FIRE TUBE BOILERS (STEAM) (15558)
SECTION 236416 - CENTRIFUGAL WATER CHILLERS (15684)
SECTION 236500 - COOLING TOWERS (15710)
SECTION 237213 - ROTARY AIR TO AIR ENERGY RECOVERY WHEELS
SECTION 237323 - CUSTOM AIR HANDLING UNITS (15854)
SECTION 237324 - SEMI-CUSTOM AIR HANDLING UNITS (15855)

SECTION 238216 - COILS AND DRAIN PANS (15820)
SECTION 238219 - FLOOR MOUNTED FAN COIL UNITS (UN-DUCTED) (15763)
SECTION 238220 - HORIZONTAL FAN COIL UNITS (15764)
SECTION 238221 - BLOWER COIL UNITS (15765)

INTRODUCTION:

Manufacturers on this list fall into three categories:

Preferred Manufacturer: Listed manufacturer's product may be used on U-M projects. However, manufacturer's product must be listed as approved in the project's contract documents or specifications. Listing in the PML does not guarantee a product will automatically be listed in a project's documents or specifications.

Conditional Approval: Listed manufacturer's product may be used on select U-M projects, however approval from the respective A & E Technical Committee must first be obtained. If approved, it may be listed as approved in the project's contract documents or specifications. Manufacturers in the Conditional Approval category have gone through successful preliminary review, but Technical Committee requires additional in-service input prior to final category listing.

Under Consideration: Listed manufacturer's product is being evaluated. The product should not be included in U-M projects.

SECTION 211313 (15300) - WET-PIPE SPRINKLER SYSTEMS

Preaction Systems

Siemens (Pyrotronics), Notifier, Viking

Piping - Grooved

Anvil Gruvlok, Victaulic

Sprinkler Heads

Reliable
Tyco
Viking
Victaulic

Tamper Switches

Grinnell, System Sensor, Victaulic

Valves - Fire Protection, Detector Check

Grinnell
Reliable
Viking
Victaulic
Hersey-Anvil
Ames

Valves - Fire Protection, Zone Control

Grinnell
Victaulic
Milwaukee
Nibco
Stockham

SECTION 213113 (15320) - FIRE PUMPS

Pumps - Fire

Allis-Chalmers
Aurora
Peerless

SECTION 220000 - UNDERGROUND PIPING IN CONDUIT SYSTEM

Piping Systems - Underground

Perma-Pipe, Rovanco, Under Consideration: Urecon

SECTION 220500 (15010) - COMMON WORK RESULTS FOR MECHANICAL

Fasteners

Refer to UM Master Specification

Fire Stopping

3M, Hilti, Tremco, Manville

Roof Curbs

Pate
Creative Metals
Roof Curbs Engineered and Manufactured by the Manufacturer of the Equipment to be supported

SECTION 220513 (15170) - MOTORS

Motors - General, Premium Efficiency Type Only - 1/2 HP and above

Reliance, Baldor, Dayton, GE, Toshiba, Leeson, Marathon, U.S. Motors

SECTION 220514 (15960) - VARIABLE FREQUENCY DRIVES

Variable Frequency Drives (and variable speed controllers)

Danfoss-Graham, Toshiba, ABB

SECTION 220516 (15125) - PIPE EXPANSION JOINTS

Expansion Joints - Bellow Type

Flexonics, Metraflex, Microflex, Twin City Hose

Expansion Joints - Externally Pressurized

Hyspan, Microflex
Expansion Joints - Slip Type (Packed) For Steam Piping – no longer used

SECTION 220519 (15130) – THERMOMETERS, PRESSURE GAUGES, AND ACC'S

Pressure Gauges

Dwyer, H.O. Treice, Weksler, Marsh, Ashcroft, Weiss

Pressure & Temperature Plugs

Pete's Plug, Schrader, Sisco

Thermometers

Industrial Glass: H. O. Treice, Weksler, Marsh, Ashcroft, Weiss,
Electronic Digital (light powered): Weiss, Techcontrols

SECTION 220523 (15100)- VALVES

Flow Measuring & Balancing Equipment - Manual Hydronic

PSE Inc.
ITT Bell & Gossett Circuit Setter
Taco
Ellison Annubar
Accuset
Armstrong
T & A (part of Victaulic)
Flow Design Inc

Valves - Automatic Hydronic Regulating/Balancing

Auto-Flow (press. indep.)
Griswold (press. indep.)
B & G (press. indep.)

Valves - Manual Hydronic Regulating

B & G
T & A
Armstrong
Taco
Flow Design

Valves - Ball With Lever Handle

Pegler
Crane
Grinnell
Jamesbury
Watts
Jomar
Milwaukee
American Valve
Nibco
Apollo
Hammond

Valves - Butterfly

Dezurik
Grinnell
Stockham
Fisher
Watts
Bray
Milwaukee
Crane
Nibco
Victaulic (for grooved piping)
Hammond
Under Consideration: Apollo

Valves - High Performance Butterfly

Bray
Crane Flowseal

Dezurik,
Fisher Not specified in MS 220523
Grinnell-GHP,
Jamesbury
Milwaukee
Tri-Seal-Valve-Contromatics (formerly Watts/KF Contromatics)
Xomox.

Valves - Lubricated Plug

Honestead, Milliken, Resun

Valves - Gas (UL Approved)

Pegler
Jomar
Watts
Grinnell
Crane
Milwaukee "Butter Ball" MS 15100 "Butter Ball" not specified.
Nibco
Hammond
Jamesbury
Apollo
American Valve

Valves - Gate

Watts
Crane
Milwaukee
Grinnell
Stockham
Nibco
Hammond

Valves - Swing Check

Milwaukee
Crane
Grinnell
Nibco

Valves - Silent Check

(except tunnels) Milwaukee, APCO, Mueller, Metraflex
Utility tunnels:
a. 2" and under: Check All
b. over 2" - Durabula, stainless body

Valves - City Water Main (Ann Arbor) (formerly OS&Y)

Kennedy 4068
Mueller A-2380
East Jordan Series A
Other valves specifically approved by the City of Ann Arbor for this application
3 piece full port ball valve: Conbraco (rep. J.O. Galloup)

SECTION 220533 (15128)– HEAT TRACING FOR PIPING

Heat Tracing

Raychem, Thermon

SECTION 220548 (15240) - VIBRATION CONTROL

Vibration Isolators

Amber Booth, Korfund, Mason, Vibration Eliminator, Vibration Isolation Co.

SECTION 220553 (15190)- MECHANICAL IDENTIFICATIONS

Pipe Markers

Brady Co. (Signmark Div.), Brimer, Craftmark, Kolbi, MSI (Marking Services Inc.),

SECTION 220719 (15250)- MECHANICAL SYSTEMS INSULATION

Insulation - Duct/Pipe/Equipment - Fiberglass

Owens Corning
Knauf
Schullers (Johns Manville)
Armstrong
Pittsburg-Corning
Certainteed

Insulation - Flexible/Elastomeric/Polyolefin

AP Armaflex, IMCOA, Nomaco K-Flex, Rubatex

Insulation - PVC Covering, Elbows and Fittings

Proto
Zeston
Ceelco

Insulation - Removable Jackets

Q-Master by ESI
Insulation Tech. Inc.

SECTION 221113 (15060) - PIPING MATERIALS & METHODS

Grooved Joints for Copper and Steel Piping (except tunnels):

Victaulic, Anvil International, Tyco Grinnell.

Grooved Joints for Copper Piping In Tunnels:

Victaulic

Dielectric Fittings

Refer to UM Master Specification

Flexible Metal Hose Connectors (Stainless)

Flex Hose Co., Flexonics, Mason, Metraflex
Under Consideration: Twin City Hose

Flexible Metal Hose Connectors (Copper)

Anaconda, Flex Hose Co., Flexonics, Mason, Metraflex

Flexible Connectors (Rubber)

Flex Hose Co., Flexonics, Garlock, Mason, Mercer Rubber Co., Metraflex

Pipe Hangers and Mechanical Supports

Anvil, Cooper B-Line, Carpenter & Paterson, PHD Manufacturing, Unistrut, Powerstrut

Thermal Hanger Shield Inserts

Cooper B-Line, ERICO International Corp, Pipe Shields Inc., Rilco Manufacturing Company, Value Engineered Products, American Mechanical Insulation Sales

Piping - Lab Waste and Vent (Polypropylene)

Enfield, Orion, Zurn

Strainers - Steam & Water

Keckley
Yarway
Mueller
Spirax-Sarco
Metraflex
Watts
Armstrong
Victaulic (grooved water piping only)
Anvil Gruvlok (grooved water piping only)

Valves - Safety Relief

Spirax-Sarco
Watts
Leslie
Anderson-Greenwood
Conbraco
Keckley

SECTION 221119 (15411) - DOMESTIC WATER PIPING SPECIALITIES**Backflow Preventers**

Ames
Conbraco
Febco
Watts
Zurn-Wilkins

Hydrants - Wall Type

Woodford
Zurn
Chicago
J.R. Smith

Vacuum Breakers - Backflow Prevention

Kewaunnee
Chicago Water Saver
Bell & Gossett
Watts
Conbraco

Valves - Water Pressure Regulating

Bell & Gossett, Conbraco, Hoffman, Keckley, Leslie, Spirax Sarco, Watts

Water Hammer Arrestors

Zurn
Watts
Josam
J.R. Smith
Sioux Chief
Wade

SECTION 221319 (15420)- DRAINAGE SPECIALITIES**Drains - Roof, Floor and Trench, Grease Interceptors**

Josam
J.R. Smith
Zurn
Wade
Watts
Sioux Chief
Under Consideration: MIFAB (V.E. Sales Co.)

SECTION 221500 (15481) - COMPRESSED AIR ACCESSORIES**Air Compressors - Screw Type (1800 RPM)**

Atlas - Copco
Quincy QSI Series

Air Compressors - Reciprocating

Quincy
Gast
Devilbliss

Air Dryers and Related Filters

Wilkinson
Zeks
Van-Aire
Hankison

Air Pressure Reducing Stations

Van-Aire
Zeks
Parker-Hannifin
Fisher
Siemens
Wilkerson

SECTION 223116 (15455) - WATER SOFTENER**Deionized Water and Reverse Osmosis Water Suppliers**

Crown Equipment Co. (Ohio)
Siemens/U.S. Filter
Ionpure
Millipore

Water Treatment Equipment - Softeners

Crown Engineering

Burmah / Venture (H.V. Burton)
Bruner (K.L. McCoy)

Water Treatment Equipment

Crown Engineering
Burmah
Bruner

SECTION 224200 (15440) - PLUMBING FIXTURES

Domestic Water Heaters - Gas Fired Or Electric

Lochinvar
A.O. Smith
State
Rheem
Raypak

Under Consideration: Copper Fin (Quality water & air)

Emergency Shower And Eyewash

Bradley, Haws, Speakman

Faucets - Automatic, Battery and Electric Type

American Standard, Chicago Faucets, Sloan, Zurn

Faucets - Manual

American Standard, Chicago Faucets, Moen

Plumbing Fixtures - Water Closets, Lavatories, Urinals And Sinks

Lavatories:

American Standard, Crane, Kohler, Sloan, Zurn

Urinals:

American Standard, Kohler, Sloan, Zurn

Water Closets:

American Standard, Crane, Kohler, Sloan

Shower Heads

American Standard, Chicago Faucet, Kohler, Speakman, Symmons

Toilet Room Fixture Supports

Josam, J.R. Smith, Wade, Watts, Zurn

Toilet Seats

Bemis, Centoco, Church

Valves - Flush Including Automatic Flushing System

Sloan, Kohler, Zurn

Valves - Shower Control Valves

American Standard, Chicago Faucet, Kohler, Powers, Speakman, Symmons

Valves - Thermostatic Mixing for Handwashing

Powers, Symmons, Wilkins

Water Coolers

Halsey Taylor, Haws, Oasis International

Water Filters - Inline Type

Cuno

Filtrine
Honeywell
Culligan
Dollinger
Bruner

SECTION 230000 - AIR COOLED CONDENSING UNITS

Air Cooled Condensers

Bohn, Dunham Bush, McQuay, Trane, York

Refrigeration Compressors

Copeland, Dunham Bush, McQuay, Tecumseh, Trane, York

SECTION 230000 - AIR COOLED PACKAGED CHILLERS

Chillers - Reciprocating, Air-Cooled

Trane, York by Johnson Controls
Under Consideration: Carrier.

Chillers - Process Cooling

Filtrine, Liebert, Trane, Neslab

Refrigeration Compressors

Tecumseh, Copeland, Trane, York, McQuay

SECTION 230000 - CAST IRON BOILERS

Boilers

Burnham, Peerless, Weil McLain

SECTION 230000 - DUCTLESS SPLIT ROOM AIR CONDITIONERS- AIR COOL

Air Conditioning Units - Ductless, Spot Coolers

Daikin, Friedrich, Liebert, Mitsubishi, Sanyo, Trane

SECTION 230000 - HEAT EXCHANGERS & CONVERTERS

Dry Coolers

McQuay, Trane, York, Bohn

Convertors (Shell & Tube) - Steam To Hot Water

Bell & Gossett, Taco, Armstrong, Mueller

Heat Exchanger - Plate & Frame

Alpha-Laval, Armstrong, Bell & Gossett, Mueller, Tranter

Laser Heat Exchangers - Water Cooled

Haskris
Remcor
Neslab
Laser Pure (Coherent)

SECTION 230000 - HUMIDIFIERS

Armstrong, Cemline, Dri-Steem, Herrmidifier, Nortec, Pure, Spirax-Sarco, Stulz

SECTION 230000 – HVAC WATER TREATMENT

Chemical Suppliers

Ques Industries, Schaefer Technologies

Chemical Shot Feeders

Bruner, Burmah, Crown Engineering, Galloup, H. V. Burton, Neptune, Venture

Corrosion Coupon Rack

Pulsafeeder

SECTION 230000 - MULTIMEDIA FILTRATION SYSTEM

Acceptable Manufacturers

Crown Equipment Systems, PEP Filters, Everfilt

SECTION 230000 - PACKAGED COMPUTER ROOM AIR CONDITIONING SYSTEM

Air Conditioning Units - Computer Room

APC, Liebert, Stulz

SECTION 230000 - PACKAGED HEAT TRANSFER UNITS

Bell & Gossett

SECTION 230000 - PACKAGED TERMINAL AIR CONDITIONERS, AIR-COOLED

Air Conditioning Units - Package Type (thru the wall self-contained DX)

IslandAire, McQuay, Trane, York

Air Conditioning Units - Window Type (Flush installation with wall exterior)

Comfort-Aire, Fedders, White Westinghouse

SECTION 230000 - STEAM ABSORPTION CHILLER

Chillers - Absorption

Trane, York by Johnson Controls

SECTION 230000 - STEAM CONDENSATE RETURN UNITS

Condensate Meters - Gravity Type - no longer used

Condensate Receiver

ITT Domestic, Skidmore, Shipco, Spirax-Sarco

Condensate Meters - Magnetic Induction

EMCO, Under Consideration: Krohne

Pumps - Boiler Feed

Skidmore, Spirax-Sarco, Shipco, Weinman

Pumps - Condensate (Condensate Receiver Must Be Cast Iron)

ITT Domestic (Hoffman), Skidmore, Spirax-Sarco, Shipco, Weinman

Pumps - Condensate, Steam Or Air Pressure Powered

Sarco, Armstrong

SECTION 230000 - TERMINAL UNITS

Baseboard Radiation, Finned Tube Radiation

Dunham-Bush, Rittling, Slantfin, Sterling Radiator, Trane, Vulcan Radiator

Panel Radiators

Jaga, Runtal Radiator, Sterling

Convectors

Dunham-Bush, Rittling, Sterling, Trane

Unit Heaters

Dunham-Bush, McQuay, Modine, Reznor, Rittling, Sterling, Trane, Wing

Cabinet Heaters

Dunham-Bush, McQuay, Modine, Rittling, Sterling, Trane

Unit Ventilators

American Air Filter, Trane

Electric Cabinet Heaters

Berko, Qmark, Trane

Electric Heating Coils

Brasch, Chromalux, Indeeco, Trane

Gas Fired Duct Furnaces

Modine, Reznor, Sterling, Trane

Radiant Ceiling Panel - Hot Water

Aero-Tech, Air-Tex, Sun-El, Sterling/TWA

SECTION 230593 (15990) - TESTING, ADJUSTING AND BALANCING

TAB Sub-Contractors

Absolut, Air Flow Testing, Enviroaire - Total Balance

SECTION 230900 (15975)- MECHANICAL SYSTEMS CONTROLS

Because of the extensive amount of control components, approved manufacturers are only listed in the controls spec. itself.

SECTION 230920 (15910)- LABORATORY TERMINAL AIR FLOW UNITS & CONTROLS

Fume Hood Monitors

Phoenix, Warrick

Laboratory Terminal Airflow Units (LTAUs)

Phoenix

SECTION 230930 (15635) - REFRIGERANT DETECTION AND ALARM

Acceptable Manufacturers

MSA Corporation

SECTION 231123 (15488) – FACILITY NATURAL GAS PIPING

Master Gas Valve Boxes

Ohmeda
Mueller

SECTION 232116 (15515) - HYDRONIC PIPING SPECIALTIES

Automatic & Manual Air Vents

Armstrong, B & G, Hoffman, Wheatley, Taco

Suction Diffusers

Armstrong, B & G, Grinnell, Taco, Victaulic, Wheatley

Triple Duty Valves

Armstrong, B & G, Taco, Wheatley

Water Pressure Relief Valve

ITT B & G, ITT McDonnell Miller, Consolidated, Watts

Water Pressure Regulating/Reducing Valve

B & G, Hoffman, Watts

Air Separators

Amtrol, Armstrong, B & G, Spirotherm, Wheatley

Coalescing Separator

Spirotherm (Spirovent Dirt HV)

Expansion Tank

Amtrol, Armstrong, Bell and Gossett, Wessels, Taco CA

Centrifugal Separator

Griswold Controls, Lakos

In-Line Filters

Bruner, Culligan, Cumo Dollinger, Honeywell

Glycol Feed Packages

Advantage Control Inc., Burmah, Crown Engineering, J.L. Wingert Co., Neptune Chemical Pump Co., Wessel Co.

Inhibited Ethylene Glycol

Dowtherm SR-1

SECTION 232123 (15160) – PLUMBING AND HYDRONIC PUMPS

Pumps - Condensate Waste

Little Giant, Hartell, Marsh, Bekette

Pumps - Double Suction - Base Mounted

Bell & Gossett (ITT), Allis-Chalmers, Weinman, Armstrong, Taco

Pumps - End Suction , Close Coupled - Base Mounted

Bell & Gossett (ITT), Allis-Chalmers, Weinman, Armstrong, Taco

Pumps - End Suction , Flexibly Coupled - Base Mounted

Bell & Gossett (ITT), Allis-Chalmers, Weinman, Armstrong, Taco

Pumps - In-Line Circulators

Bell & Gossett (ITT), Armstrong, Grundfos, Weinman, Taco

Pumps - In-Line Close Coupled - Hanger Supported

Bell & Gossett (ITT) Series 60, Grundfos, Armstrong, Weinman, Taco 1600

Pumps - In-Line Split Coupled - Base Mounted

Bell & Gossett (ITT) Series 80-SC, Grundfos, Armstrong, Weinman, Taco KS Vertical Split Coupled

Pumps - Sump Pumps

Vertiflo (B&G), Allis Chalmers, Weinman, Armstrong, Zoller, Weil
Under Consideration: Aurora / Hydromatic (K.L. McCoy)

Pumps - Vacuum

Nash
Domestic
Sehi
Shipco
Under Consideration: Skidmore (K.L.McCoy), Busch (Kerr pump & supply)

SECTION 232216 (15525) - STEAM AND CONDENSATE PIPING SPECIALTIES**Steam Pressure Reducing Stations**

Armstrong, Jordan, Leslie, Spence, Spirax-Sarco, Watts Anderson-Greenwood

Steam Traps - All Types

Armstrong, Spirax Sarco, Hoffman (ITT), Watson McDaniels

Flash Tank, Vacuum Breaker, Drip Pan Elbow, Pressure Reducing Valve

See Master Specification for these items.

SECTION 232300 (15530)- REFRIGERANT PIPING**Valves - Refrigeration**

Asco, Hansen, Henry Valve, Parker, Sporlan

SECTION 232519 (15188)- STEAM BOILER CHEMICAL WATER TREATMENT

Refer to master specification 232519

Seton

SECTION 233100 (15890) - HVAC DUCTS & CASINGS**Exhaust Ductwork - PVC Coated**

United McGill, Tangent, Foremost, Semco

Exhaust Ductwork - Teflon Coated Stainless Steel

Fab-Tech (PermaShield Pipe)

Exhaust Ductwork - FRP

Perry, Spunstrand, Tangent

Flexible Non-Metallic Duct

Atco (Flex-Aire), Flexmaster, Hart & Cooley (Genflex)

Double-Walled Panels, Plenums, and Duct at Outside Air Intake Plenums

McGill Airflow LLC., Semco Mfg Co., VAW Systems, Vibro-Acoustics

Clothes Dryer Vent Ductwork

Intended for heavy use clothes dryer applications such as resident hall laundry rooms with multiple dryers where access to disassemble duct for periodic cleaning may be challenging. For simple dryer applications, specifying conventional duct may be more appropriate.

Nordfab Quick-Fit/ACS, Fenton, MO

Duct Sealants

Hardcast, McGill Airflow LLC. , Polymer Adhesives, Ductmate, Childers/Foster

SECTION 233300 (15895)- AIR DUCT ACCESSORIES & RGDS**Duct Flexible Connectors**

Ductmate, Duro-Dyne, Fanair, Pathway, United McGill, Ventglas

Dampers - Fire, Smoke, Combination Fire/Smoke

Air Balance, American Warming & Vent, Greenheck, Nailor, Ruskin, Vent Products

Dampers - Balance (manual volume control)

American Warming & Vent, Arrow, Flexmaster (for round ducts, single branch takeoff only), Ruskin, Greenheck, Krueger, Vent Products, Young Regulator

Dampers - Iris

Continental Fan Manufacturing Inc.

Dampers - Backdraft

Young Regulator Company.
American Warming & Ventilating Co.
Vent Products Co., Inc.
Arrow United Industries.

Sound Attenuators

IAC, Semco, Ruskin, United McGill, VAW Systems, Vibro-Acoustics, Price

Registers, Grilles and Diffusers

Carnes, E.H. Price, Krueger, MetalAire, Nailor, Titus, Tuttle & Bailey

Louvers

American W. & V., Ruskin, Vent Products

Ductwork Cleaning Specialist

Sani-Vac, Power Vac, High Tec Vacuum, Aero Filters Inc., Stanley Steemer Great Lakes Inc.

SECTION 233400 (15870)- FANS**Fans: All types except Vane and Tube Axial, FRP, High-Plume Induction Lab Type**

Aerovent, Acme, Barry Blower, Buffalo, Carnes, Greenheck, Loren Cook, Penn, Trane, Twin City

Fans - High-Plume Induction-Type Lab Exhaust

Greenheck - Vektor , Strobic,

Fans -FRP Construction

M.K. Plastics
Under Consideration: Harrington

Fans -Vaneaxial, TubeAxial

Buffalo, Cook, Greenheck, Joy, Trane, Woods

SECTION 233600 (15896)- AIR TERMINAL UNITS**VAV, CAV, Dual Duct, and Retrofit Terminal Air Flow Units**

Carnes, Titus, Krueger, Metalaire, Nailor Industries, Inc., Price Industries, Tuttle and Bailey

SECTION 234000 (15885)- HVAC AIR CLEANING DEVICES

Primary Filters, Secondary Filters and Filter Housing Rack

American Air Filter, Camfarr, Eaton, Flanders, Purolator, Tri-Dim

HEPA Filters

Camfarr, Eaton, Flanders

Gas Adsorption Filters

American Air Filter, Camfarr, Charcoal Service Corp., Flanders, Purolator

Filter Gauges

Bacharach Instrument Co., Deiterich Standard Corp., Dwyer, Moeller Instrument Co.

SECTION 235100 (15575)- BREECHINGS, CHIMNEYS, AND STACKS

Boiler Stack

Metalbestos, Metal-Fab, Van Packer, Schebler, AMP Co

SECTION 235239 (15557) - FIRE TUBE BOILERS (HOT WATER)

Boilers

Easco, Johnston, Superior , Conditional Approval: Hurst Boilers

Burners

Webster

Under Consideration: Viessmann

SECTION 235240 (15558)- FIRE TUBE BOILERS (STEAM)

Boilers

Bryan, Unilux

SECTION 236416 - CENTRIFUGAL WATER CHILLERS

Chillers - Centrifugal

Trane, York by Johnson Controls

Chillers - Screw or Scroll

Dunham-Bush

York by Johnson Controls

Trane

SECTION 236500 (15710)- COOLING TOWERS

Cooling Towers

Baltimore Air Coil, Marley, EVAPCO

SECTION 237213 - ROTARY AIR TO AIR ENERGY RECOVERY WHEELS

Semco, Desicant Rotors International

SECTION 237323 (15854) - CUSTOM AIR HANDLING UNITS

Air Handlers

Air Enterprises, Air Flow Equipment, Buffalo Air Handling, Governair LLC, Mafna Air Conditioning, Inc., TMI Custom Air Systems, Ventrol.

Air Blenders

Blender Products Inc., R.M. Products

Gas Fired Make-Up Air Units (direct and indirect)

Rapid, Reznor, Sterling, Trane
Under Consideration: Modine (Air Design), Greenheck

SECTION 237324 (15855) - SEMI-CUSTOM AIR HANDLING UNITS

Air Handlers

Air Flow Equipment, Buffalo Air Handling, Governair LLC, Mafna Air Conditioning, Inc., McQuay, Thermal Corporation, TMI Custom Air Systems, Trane, Ventrol

Air Blenders

Blender Products Inc., R.M. Products

SECTION 238216 (15820) - COILS AND DRAIN PANS

Aerofin, Heatcraft, Marlo, McQuay, Trane, USA Coil, Ventrol, York, Coil Replacement Co

SECTION 238219 (15763)- FLOOR MOUNTED FAN COIL UNITS (UN-DUCTED)

Airtherm, Enviro-Tec by Johnson Controls, International Environmental Corporation, Rittling

SECTION 238220 (15764) - HORIZONTAL FAN COIL UNITS

Airtherm, Enviro-Tec by Johnson Controls, International Environmental Corporation, Mcquay International, Price, Trane, Zehnder Rittling

SECTION 238221 (15765) - BLOWER COIL UNITS

Airtherm, Enviro-Tec by Johnson Controls, International Environmental Corporation, Mcquay International, Price, Trane



- HOME
- ABOUT US
- PROJECTS
- MAPS & DETOURS
- MASTER PLANNING
- POLICIES & PROCEDURES
- SUSTAINABILITY
- SAFETY

- FOR U-M CLIENTS
- FOR VENDORS
- FOR U-M AEC STAFF

OUT TO BID

DESIGN GUIDELINES

CODES & REGULATORY AGENCIES

DESIGN DELIVERABLES

SUSTAINABILITY

SPECIAL INSTRUCTIONS TO DESIGNERS

SPECIAL BUILDING AREAS

OFFICE SPACE

TECHNICAL SECTIONS

STANDARD DETAILS

MASTER SPECIFICATIONS

PREFERRED MANUFACTURERS

HEALTH SYSTEM PROJECTS

EFFECTIVE DATE

BUILDING COMMISSIONING

CONTRACTS & AGREEMENTS

CONTRACTOR RESOURCES

OTHER LINKS

HEALTH SYSTEM PROJECTS

[UM Hospitals and Health Centers Facilities Planning and Development web page](#) contains design guidelines that are specific to University of Michigan Hospitals and Health Centers projects.

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- HOME
- ABOUT US
- PROJECTS
- MAPS & DETOURS
- MASTER PLANNING
- POLICIES & PROCEDURES
- SUSTAINABILITY
- SAFETY

- FOR U-M CLIENTS
- FOR VENDORS
- FOR U-M AEC STAFF

OUT TO BID

DESIGN GUIDELINES

CODES & REGULATORY AGENCIES

DESIGN DELIVERABLES

SUSTAINABILITY

SPECIAL INSTRUCTIONS TO DESIGNERS

SPECIAL BUILDING AREAS

OFFICE SPACE

TECHNICAL SECTIONS

STANDARD DETAILS

MASTER SPECIFICATIONS

PREFERRED MANUFACTURERS

HEALTH SYSTEM PROJECTS

EFFECTIVE DATE

BUILDING COMMISSIONING

CONTRACTS & AGREEMENTS

CONTRACTOR RESOURCES

OTHER LINKS

EFFECTIVE DATE

Compiled Design Guidelines by Month and Year

These Design Guidelines are *only* for use by consultants and contractors in connection with work performed for the University of Michigan. They are to be used as a guide in the preparation of design documents for University of Michigan construction projects. They are not intended to relieve the designers and contractors from their responsibility to comply with applicable codes and other contract obligations.

The purchasing contract and schedule of project details incorporate the Design Guidelines that are applicable to the project.

- [July 2014](#) 
- [June 2014](#) 
- [May 2014](#) 
- [April 2014](#) 
- [March 2014](#) 
- [February 2014](#) 
- [January 2014](#) 
- [December 2013](#) 
- [November 2013](#) 
- [October 2013](#) 
- [September 2013](#) 
- [August 2013](#) 
- [July 2013](#) 
- [June 2013](#) 
- [May 2013](#) 
- [April 2013](#) 
- [March 2013](#) 
- [February 2013](#) 
- [January 2013](#) 
- [December 2012](#) 
- [November 2012](#) 
- [October 2012](#) 
- [September 2012](#) 
- [August 2012](#) 
- [July 2012](#) 
- [June 2012](#) 
- [May 2012](#) 
- [April 2012](#) 
- [March 2012](#) 
- [February 2012](#) 
- [January 2012](#) 
- [December 2011](#) 
- [November 2011](#) 
- [October 2011](#) 
- [September 2011](#) 
- [August 2011](#) 
- [July 2011](#) 
- [June 2011](#) 
- [May 2011](#) 
- [April 2011](#) 
- [March 2011](#) 
- [February 2011](#) 

- [January 2011](#) 
- [December 2010](#) 
- [November 2010](#) 
- [October 2010](#) 
- [September 2010](#) 
- [August 2010](#) 
- [July 2010](#) 

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