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<td>Chilled Water – Supply &amp; Return Piping</td>
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<td>23B</td>
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<td>Heating Water – Supply &amp; Return Piping</td>
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<td>Description</td>
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<td>23G</td>
<td>Steam Condensate Piping – High Pressure</td>
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INTRODUCTION

Washington University in St. Louis manages the design, construction, and maintenance of new and existing buildings and infrastructure on the Danforth Campus through the Department of Facilities Planning & Management (FPM). This department ensures all design and construction proceeds in a manner consistent with the policies of the Board of Trustees of the University to provide maximum support to the mission of the University.

To that end, Facilities Planning & Management engages leading design professionals from the local and national community to develop projects which support world class research, teaching, patient care, and service to society. Each project serves the mission of the University, regardless of size, cost, or prominence. Therefore, the University encourages all design professionals engaged in activities on behalf of the University to use the highest degree of professional skill and expertise and to approach each project with a collaborative, creative, responsive, and transparent mindset throughout the project life cycle.

The FPM staff is comprised of professionals with significant industry experience in architecture, engineering, construction, and finance. This staff strives to work with the design professionals and installing contractors in a cooperative manner to assist them in successfully achieving the objectives of the respective project. At the formation of a project, Washington University (WU) assigns a Project Manager (PM) to oversee the project throughout the programming, design, construction, and closeout phases. The PM and design team will work jointly to ensure the scope, budget, and schedule meet the needs of all stakeholders.

FPM prepared this Design Guide to provide design professionals with a comprehensive resource for developing projects at the University. This living document conveys important information to design professionals regarding:

1. Design Guide goals
2. University operating environment
3. Expectations of design professionals
4. General information related to the University
5. University standards for new construction and renovations

Washington University expects all design professionals to proactively read, understand, and implement the information provided in the Design Guide.

Design Guide Goals

This Design Guide provides information and instruction to design professionals for new construction and renovation projects. The guide was prepared with the following topics in mind:

1. Philosophy: The guide seeks to balance brevity, clarity, and thoroughness.
2. Audience: The primary audiences of this guide are the architects, engineers, and other consultants who assist the University in developing projects.
3. Content: The Design Guide conveys crucial University requirements design professionals shall incorporate into their drawings and specifications. The sections presented herein do not replace specifications produced by the design team.
4. Format: The technical sections of the Design Guide utilize the 2016 MasterFormat numbering convention developed by the Construction Specifications Institute (CSI). The information is arranged in three parts within each section:
a. Part 1: General information, including a summary of the section, related information, and crucial design considerations and requirements
b. Part 2: Product and provider information, including preferred or sole source products and manufacturers
c. Part 3: Execution instructions, including text which the design team shall copy verbatim into project documents

5. Limitations: The Design Guide does not relieve nor limit the design team’s professional or contractual responsibility, nor restrict the creativity of the design professional. Submit proposed deviations to the WU PM.

6. Relevance: WU intends to maintain the usefulness of this Design Guide by providing annual updates and indicating significant changes between the current and previous version of this Design Guide.

**University Operating Environment**

**Administration**

Understanding WU’s leadership structure will assist design professionals with developing projects which meet University schedules, expectations, and budgets. Design professionals are encouraged to review WU’s website to familiarize themselves with the mission and members of the University.

The WU PM will assist the design team with scheduling meetings with the appropriate WU stakeholders.

**Project Budgeting**

Designing a project to meet the University’s budget is essential. At the beginning of a project, WU distinguishes between two cost categories:

1. Construction costs
   a. Construction manager, general contractor, and subcontractor costs
2. Project costs
   a. Direct costs: Testing/inspections, moving, signage, environmental
   b. Internal costs: WU IT labor & equipment, facilities/maintenance, incidentals, FF&E
   c. Soft costs: Design fees, audit fees, project assessments
   d. Contingency: Design & construction contingency

Thus, the Total Project Cost is the sum of items 1 and 2 above. During the planning phases of a project, the project team will often need to design to a Construction Cost based on a historical estimate of the Project Costs. WU often refers to this as a Construction Cost “Multiplier”, expressed below in equation format:

\[
\text{Construction Costs} \times \text{Multiplier} = \text{Total Project Cost}
\]

\[
\text{Construction Cost} + \text{Project Costs} = \text{Total Project Cost}
\]

Consult with the WU PM to determine the correct Multiplier to use during the planning phases of the project.
Funding Approvals

The University funding approval cycle will often drive the design schedule. Depending on the size of the project, FPM will obtain funding approval from various, successive levels of the University administration. The following matrix identifies the maximum project approval authority and the approximate schedule. Consult with the WU PM for specific approval requirements or unique adjustments:

<table>
<thead>
<tr>
<th>Total Project Cost</th>
<th>Approval Committee</th>
<th>Meeting Schedule</th>
</tr>
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<tbody>
<tr>
<td>$2,000,000</td>
<td>Projects Committee</td>
<td>Monthly</td>
</tr>
<tr>
<td>$5,000,000</td>
<td>Facilities &amp; Campus Planning Committee</td>
<td>Bi-monthly</td>
</tr>
<tr>
<td>Greater than $5,000,000</td>
<td>Executive Committee</td>
<td>Bi-monthly</td>
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</tbody>
</table>

Expectations of Design Professionals

Contracts

The University General Counsel and FPM have developed a suite of WU-specific design contract documents which define the service requirements and which are available online. Consult with the WU PM to determine the appropriate contract form for the project. The information presented below offers commentary about the contract requirements.

The Architect Agreement, Engineering Agreement, and Consulting Services Agreement outline basic definitions, responsibilities, project phases, and other important project information for the design team. The design team is encouraged to read and understand the applicable documents prior to submitting a proposal for design services to the University.

Fees

The Board-approved Washington University Fee Schedule defines the Architectural Basic Services fee and is included as Schedule 01 “A/E Fee Schedule.” FPM negotiates Supplemental Fees for additional consultants on an as-needed basis. Consult with the WU PM to evaluate the correct tier and multiplier, or for projects which do not fit the Fee Schedule.

Document Reviews

The University conducts internal document reviews to ensure the project meets University requirements. This review is not a substitute for the design professional reading, understanding, and implementing the material in this Design Guide. Rather, it serves as an opportunity to review unique conditions, discuss proposed deviations, and interact with the project documents to date. Document reviews occur at major project milestones and generally follow this format:

1. The design team and WU agree on project milestone dates.
2. The design team delivers digital project documents on milestone date.
3. The WU PM distributes digital project documents for internal review and requests digital comments within a reasonable timeframe given project size, typically within 5-7 business days.
4. The WU PM combines digital comments and returns to design team, typically within 2-3 business days.
5. The design team delivers responses to drawing comments, typically within 3-4 business day.
6. The design team, WU, and construction team (if a Construction Manager is involved) review drawings during an in-person page turn, typically within 3-4 days. The Architect leads this on-site meeting, which may take an entire day, depending on project size and phase. The team reviews all disciplines of the
Contract Documents and WU strongly encourages all consultants to attend the applicable portion of the meeting.

**Change Order Review**

Contractors are responsible for submitting proposed change orders (called “Online Change Requests”, or “OCRs”) to WU and the design team. Approved OCRs are regularly combined (often monthly) into a Change Order (CO), depending on the needs of the project. The WU PM, design team, and contractor will determine a process to ensure timely and thorough review and approval of the OCRs. Generally, this process includes the following steps:

1. The contractor simultaneously submits a complete and correct OCR to the design team and WU, based on a checklist provided with the OCR template.
2. The design team and WU review the OCR independently, then collaborate to issue comments back to the contractor. Based on the OCR construction value, the WU PM may require an internal peer review.
3. If necessary, the contractor resubmits a revised OCR to the design team and WU PM. The design team and WU may reject the resubmitted OCR and the process will start over if the OCR is unacceptable.
4. Upon agreement of the scope and cost, the WU PM will consult with the design team and determine a Reason Code for the change. The WU PM is solely responsible for determining the reason code.
5. The WU PM, WU peer reviewer, and design team successively sign the OCR (digital signatures are acceptable).
6. The WU PM submits the OCR for inclusion in the next Change Order.

Sometimes, the project team conducts OCR discussions via email and web conferences. Often, the WU PM will set recurring OCR/CO meetings to manage the OCR/CO process.
General Information

00 10 00 – Solicitations to Bid

WU utilizes ScoutRFP (also known as Workday Strategic Resourcing), an online procurement software, to invite and manage bidding for small- and medium-sized construction projects. In the past, the design team was integral to editing the source documents for project RFPs. Moving forward, WU expects the design team to collaborate directly in ScoutRFP. Specifically, this includes:

1. Inputting project data
2. Uploading bid documents and addenda
3. Reviewing and responding to pre-bid RFIs

For large projects, the construction manager invites subcontractors and manages subcontractor bidding.

00 24 00 – Procurement Scopes

WU routinely builds and renovates projects of all sizes and has learned through experience some scopes of work warrant a specific design and procurement schedule. The design team shall prepare early bid packages, assist the project team in subcontractor selection, and incorporate subcontractor detailing/coordinating requirements for the following scopes of work:

1. Elevators
2. Curtain wall, including structural backup
3. Motorized shades, including line voltage, low voltage, and support requirements
4. Chillers & central cooling equipment

00 31 00 – Available University Existing & Record Document Information

The University maintains an extensive collection of information regarding our physical facilities. Design teams should inquire with the WU PM to obtain information about existing conditions. The following sections describe the available information:

00 31 19 – Existing Condition Information

Existing Building Drawings

WU maintains an extensive collection of physical documents, including construction drawings, renovation drawings, submittals, and other pertinent information, of nearly every building on campus. FPM is currently digitizing this collection of documents. Design teams should request a records search through the WU PM when initiating any project on campus.

Existing Building Floor Plans

WU maintains current floor plans of all buildings in CAD (.dwg) format. Design teams should request existing building floor plans through the WU PM when designing renovation projects in existing buildings.

Geospatial Information Systems (GIS) documentation

WU maintains a GIS database of the campus, including utility systems, campus features, and building information. The GIS database contains high resolution aerial photographs, landscape inventories, emergency
responder information, accessibility information, and a plethora of other data. Design teams should request any information pertinent to their work when designing projects on campus.

**Other Information**

The design team should investigate other resources during design:

1. WU drone with infrared scanning, high resolution photography, topographic scanning, and other capabilities
2. WU human resources, including staff and faculty with knowledge of some undocumented conditions
3. Missouri Historical Society Archives (particularly for off-campus projects), including historic photos and maps

**00 31 21 – Survey Information**

WU has survey grade information for the following:

1. East End of the Danforth Campus: Grimes Consulting, 2012 (original), February 2017 (current)
3. South 40: Horner & Shifrin, June 2017

**00 31 24 – Environmental Assessment & Hazardous Material Information**

WU FPM and WU Environmental Health & Safety (EH&S) maintain a significant database of environmental assessments, hazardous materials, and remediation information. Typically, WU will conduct environmental assessments and remediation operations prior to beginning a project.

**00 31 31 – Geophysical & Geotechnical Data**

The University routinely renovates portions of existing buildings which do not require a site specific geotechnical investigation. However, the Code requires a seismic Site Class for various architectural, structural, and MEP/FP improvements. While assuming Site Class “D” is permissible by Code, WU is best served by utilizing a less critical Site Class “C” when applicable.

WU engaged a local geotechnical firm to aggregate decades of geotechnical information and determine which portions of the Danforth Campus and South 40 conform to a Site Class “C.” The design team shall review Appendix 01 “WU Seismic Site Classification” to determine the applicability of this document to the specific project. If applicable, include the sealed letter and other pertinent information from the Appendix in the permit submittal.

Additional information concerning geotechnical engineering and materials testing/special inspection services is contained in Section 02 “Geotechnical & Testing Services.”

**00 50 00 – Contracting Forms and Supplements**

The University General Counsel and FPM have developed a suite of WU-specific construction contract documents which are available online. Consult with the WU PM for the correct contract documents for each project.

The CM with GMP Agreement, Short Form Agreement, and Stipulated Sum Agreement outline basic scope, schedule, cost, and other requirements for the construction team. These contracts incorporate the WU General
Conditions and WU Labor Rates. Read and understand the WU General Conditions document to inform the preparation of the project-specific Division 01 specifications.

**01 00 00 – General Requirements**

WU mandates adherence to the CAD standards defined in Appendix 02 “WU CAD Standards.”

For all new buildings, include an additional table on the Code sheet indicating the following information as defined by the Institute of Education Sciences (IES) Postsecondary Education Facilities Inventory and Classification Manual (FICM), 2006 edition:

1. Gross square feet (GSF)
2. Net assignable square feet (NASF)
3. Shell space SF

**01 18 00 – Project Utility Sources**

The University maintains a private system of water, electric, natural gas, chilled water, heating water, steam, sewers, and IT infrastructure. Connections to these networks requires an understanding of the various systems. See Section 33 “Campus Utility Services” for additional information.

**01 35 73 – Delegated Design Procedures**

Due to past challenges with delegated design, submit a list of all delegated design scopes of work for review and approval by the WU PM prior to completion of the 50% DD and 100% CD phases of work.

**01 41 00 – Regulatory Requirements**

The Danforth Campus and South 40 span three jurisdictions. The design team shall determine and confirm the specific jurisdiction for each project based on Figure 01 “WU Campus Map.” The following matrix identifies the appropriate AHJ for various jurisdictions:

<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>AHJ for Zoning &amp; Building Code Requirements</th>
<th>AHJ for Fire Code Requirements</th>
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<tbody>
<tr>
<td>Unincorporated St. Louis County</td>
<td>St. Louis County</td>
<td>City of Clayton</td>
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<td>City of Clayton</td>
<td>City of Clayton</td>
<td>City of Clayton</td>
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<tr>
<td>St. Louis City</td>
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<td>St. Louis City</td>
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There are numerous, unique situations in which the entire project team will work with governmental agencies to complete the project:

1. Fire protection: WU contracts directly with the City of Clayton for fire protection for the unincorporated portions of the Danforth Campus.
2. Off-campus projects, including WU facilities in University City (560 Music Center, 560 Garage, etc.) and other portions of Unincorporated St. Louis County (Tyson Research Center), Clayton (South Campus, West Campus), and St. Louis City (North Campus).
3. City of Clayton Conditional Use Permit
4. St. Louis City Conditional Use Permit

Consult with the WU PM for additional information when projects include these items or for other off-campus projects.
In some instances, WU’s Office of Governmental Affairs & Community Relations may need to be involved in meetings with government agencies. Discuss necessary meetings with government agencies with the WU PM prior to contacting the government agency.

WU, in conjunction with a local civil engineering firm, and the Metropolitan St. Louis Sewer District (MSD) maintain a storm water masterplan across the Danforth Campus and South 40. The design team shall bring all projects which impact storm water management to the attention of WU PM and WU Utilities.

01 42 00 – Reference Documents

WU FPM incorporates the design and construction requirements of other WU departments:

1. Danforth Structured Low Voltage Wiring Standard
2. Washington University Financial Modeling Guidelines
3. Washington University Strategic Plan for Sustainable Operations

01 60 00 – Product Requirements

WU operates with several vendors on a sole source basis to provide continuity with existing systems. Additionally, the sole source providers serve as technical resources and provide design assistance during the design phase. The WU PM and design team should collectively engage these key vendors in an unofficial design-assist role during the design process and milestone reviews. Additional information related to these providers is contained within individual standards sections.

1. Lighting Controls: Enlighted
2. Building Automation Systems: Johnson Controls Inc.
3. Fire Alarm Systems: Johnson Controls (formerly Simplex)
4. Access Control and CCTV: PASS Security

01 77 00 – Closeout Procedures and Submittals

Carefully read and understand the project closeout requirements in the applicable contract. Because WU owns and maintains buildings and infrastructure for a long duration, FPM rigorously evaluates closeout documents. The following commentary supplements and clarifies the contract requirements:

The closeout submittal process typically consists of the following steps:

1. The contractor submits redline drawings (“as-builts”) to design team for review.
2. The design team reviews redline drawings (“as-builts”) and requests clarification and additional information as required.
3. The design team updates project documents as a “Draft Record Document” package and submits to WU PM for review.
4. The WU PM coordinates internal review of “Draft Record Documents” and returns comments to design team.
5. The design team reviews comments, requests additional clarification and information from the contractor, and submits project documents as a “Final Record Documents” package. The design team is responsible for correcting and updating the “Final Record Documents” until all University comments are incorporated.

Submit draft and final Record Document packages as follows:
1. 100% digital. Hard copies are not acceptable. Transmit files via a file sharing website.
2. Submit all record documents as a searchable, navigable, and reasonably bookmarked PDF. Submit CAD, RVT, JPG, TIFF, DOC, XLSX, video, etc., file types as supplements to the PDF file.
3. Do not submit files created from scans of hard copies unless approved by the WU PM and when the project team demonstrates it cannot obtain PDF files from the original source.
4. Create file names descriptive of the content, e.g., project drawing file names shall include the sheet number and name (“S101 General Notes”) and product information shall include the specification section and product description (“051200-003 Structural Steel Shop Drawings Sequence 3”).
6. Bind multi-page information to a single set representing the whole of the content. It is acceptable to split drawing packages into volumes to limit file size.

Ensure the Record Documents contain the following, minimum:

1. Division 01
   a. Cover page with project name, WU project number, building name, date of substantial completion, and contractor name
   b. Full table of contents for the Record Document submittal
   c. Project directory with Owner’s representative, full design team, contractor, subcontractors, and owner furnished items
   d. Permit directory with associated numbers of all MSD, building, mechanical, electrical, plumbing, fire protection, and other permits.
   e. Certificates:
      i. Certificate of Occupancy
      ii. Executed Certificate of Substantial Completion
   f. Warranties
      i. A list of all warranties identifying the product, manufacturer, and warranty period
      ii. Contractor and subcontractor warranty letters
   g. Reports
      i. Test and Balance reports
      ii. A/E approval of Test and Balance report
      iii. Commissioning reports
      iv. Testing and special inspection reports, whether provided by WU or contractor
   h. Maintenance schedules, including filter schedules, belt schedules, light schedules, etc.
      i. Records of Owner training sessions, including attendance and topics
2. All other divisions
   a. Shop drawings, submittals, product data sheets, MSDS, etc.
   b. WU does not retain physical samples. Ensure the contractor submitted a photograph of all material samples in the submittal process.
   c. Operation & Maintenance manuals (specific to the equipment or with the installed equipment identified on the first page of the manual)
   d. Warranties
3. Project drawings and specifications
   a. Ensure drawings conform to the requirements of the Appendix “WU CAD Standards.”
   b. Ensure contractor redlines (“as-builts”) of drawings and specifications include reference to all RFIs, ASIs, or other changes.
c. Record drawings and specifications shall reflect all changes made throughout the project. Make revisions to the documents as required. Turn off revision clouds for final submission.

WU currently implements asset tagging. Coordinate with the WU PM for additional instructions.
SUSTAINABLE DESIGN REQUIREMENTS

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PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Sustainable design requirements
   2. LEED coordination

B. Related sections
   1. WU Strategic Plan for Sustainable Operations
   2. WU Financial Modeling Guidelines
   3. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Where referenced below, “LEED requirement(s)” refers to the current version of LEED published at the beginning of the Schematic Design phase.

B. Regardless of project size, specify waste management and disposal per the WU Strategic Plan for Sustainable Operations. Coordinate with the Sustainable Design & Construction (SDC) PM for project-specific diversion rates and requirements for monthly reporting of specific waste material streams to WU PM and SDC PM.

C. Design and ensure all new buildings and renovations incorporate green building principles based upon the following:
   1. Projects with a construction value below $2 million:
      a. WU does not require selection of a LEED rating system, project registration with the USGBC, completion of a LEED Project Checklist, or documentation submission to USGBC for project LEED certification at any level.
      b. Review green building goals with the WU PM and SDC PM during the conceptual design phase.
      c. Incorporate green building principles and best practices into the design. Ensure design and construction practices, and all material selections and their installation, comply with LEED requirements for relevant credit categories.
   2. Projects with a construction value between $2-$5 million:
      a. WU may require selection of a LEED rating system, project registration with the USGBC, completion of a LEED Project Checklist, and documentation submission to USGBC for LEED Silver as the minimum project certification level. Consult with the WU PM and SDC PM to determine the applicability of this requirement.
      b. Review green building goals with the WU PM during the conceptual or preliminary design phase.
      c. Incorporate green building principles and best practices into the design whether or not the project seeks LEED Silver as the minimum certification level. Ensure design and construction
practices, and all material selections and their installation, comply with LEED requirements for relevant credit categories for the most applicable rating system.

3. Projects with a construction value above $5 million:
   a. WU requires selection of a LEED rating system, project registration with USGBC, completion of a LEED Project Checklist, and documentation submission to USGBC for LEED Silver as the minimum project certification level. Consult with the WU PM and SDC PM to select the most appropriate rating system and certification level on a per project basis.
   b. WU leads and requires project teams participate in three sustainability charrettes prior to the end of Schematic Design, Design Development, and early Construction Documents phases in order to implement an integrated design process that includes identification and tracking of relevant sustainability goals, LEED priority credits, and life cycle cost impacts of design options.
   c. Review green building goals with the WU PM and SDC PM during the conceptual design phase.
   d. Ensure design and construction practices, and all material selections and their installation, comply with the LEED requirements for the most applicable rating system.
   e. Provide a life cycle cost analysis of various design options, including energy cost projections using WU utility data.
   f. Provide a life cycle analysis for 30-year impacts of the design on GHG emissions and energy use.
   g. WU requires projects exceed the following energy savings when compared to ASHRAE 90.1-2010:
      1) New construction: 30% better
      2) Renovation: 20% better
   h. Perform energy modeling and submit to WU at the completion of the SD, DD, and CD design phases. At the completion of the project, update the energy model to reflect as-built conditions and provide electronic files to WU.

4. LEED Credits
   a. WU requires the following LEED credits:
      1) Indoor Air Quality assessment
   b. WU typically obtains the following non-building LEED credits:
      1) Sensitive land protection
      2) Surrounding density and diverse uses
      3) Access to quality transit
      4) Advanced energy metering
      5) Enhanced refrigerant management
      6) Regional priority: Access to quality transit
      7) Regional priority: Rainwater management
      8) Regional priority: Surrounding density and diverse uses
      9) Regional priority: Optimize energy performance

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

A. Submittals
   1. Require submission of “Construction Waste Management and Disposal” submittal

PART 2 PROVIDERS & PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

WU DANFORTH DESIGN GUIDE
SUSTAINABLE DESIGN REQUIREMENTS
REVISED 2021
PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Geotechnical engineering
   2. Material testing and special inspection services

B. Related sections
   1. Appendix 01 “WU Seismic Site Classification”
   2. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Coordinate with WU to award contracts for geotechnical engineering and material testing/special inspection services to one firm.

B. Geotechnical services
   1. The Architectural Services Agreement requires the project Architect to retain geotechnical engineering services as a consultant on the design team.
   2. During Programming, obtain proposals from three geotechnical engineering firms on behalf of WU for subsurface investigation reports and recommendations. At a minimum, the proposal shall include the following services:
      a. Quantity and type of borings
      b. Quantity and type of soil and rock tests
      c. Recommendations for:
         1) Site grading
         2) Preferred and alternative foundation options
         3) Subgrade preparation and floor slabs
         4) Lateral earth pressures, swell tests, and suitable backfill material based on USGS classification criteria
         5) Backfill details, including consideration of drain tile, native soils, fill soils, waterproofing, rock chimney, geotextile fabric, and other requirements
         6) Pavements, seismicity, and detention structures
         7) Additional services
   3. Coordinate with the WU and structural engineer to ensure geotechnical firms provide equivalent services and all necessary information and recommendations.
   4. Coordinate proposed boring locations with WU and the Structural Engineer.

C. Testing and inspection services
1. During Programming, WU will obtain a separate proposal from the same geotechnical firms to perform materials testing and special inspections which includes the following information:
   a. Basis of all costs (estimated number of tests, number of trips, number of hours, and hourly rates for personnel)
   b. A schedule of guaranteed unit prices for additional work (if required)
   c. A statement of insurance coverage
   d. Anticipated schedule

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

   A. Submittals
      1. Coordinate submission of special inspection and testing reports to authorities having jurisdiction.
      2. At the completion of the geotechnical report, coordinate submission of GIS boring locations.

PART 2 PROVIDERS & PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED
PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Structural concrete
   2. Non-structural concrete

B. Related sections
   1. Section 32 00 00 “Exterior Improvements”
   2. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Programming
   1. WU prefers to limit exposed structural concrete in new buildings. Where exposed concrete is a design requirement, coordinate with the construction manager to understand the capabilities and limitations of the forming system prior to GMP pricing.
   2. In new concrete construction, electrical rooms, mechanical equipment rooms, corridors, and other locations that are hanger intensive, coordinate with design team to specify threaded inserts placed at a maximum of 4’ on center each way. The intent is that new construction and future renovations may utilize this system for MEP support.
   3. WU prefers to isolate entire slabs in mechanical rooms in lieu of individual pieces of equipment. Coordinate with WU, the building mechanical engineer, the campus utility engineer, and the acoustic/vibration engineer to properly detail this system.

B. Drawings & specifications
   1. Provide floor and roof loading diagrams in the project drawings.
   2. Provide diagrams in the project drawings indicating zones where concrete coring and drilling is not acceptable.
   3. Coordinate design and specifications to forbid electrical conduit or mechanical piping installation in concrete decks, concrete walls, and concrete slabs on grade.
   4. Design and specify a nominal 4” high x 6” wide block out located directly below the slab and near mid-span for future use in all concrete beams.
   5. Specify moisture mitigation below adhered flooring. Review costs with the project team for moisture mitigation throughout entire project.

C. Constructability
   1. Contractors routinely install floor drains above the slab elevation. Detail floor drain and sump within a separate, doweled, 24” diameter zone as a second pour.
   2. Specify and detail chamfers at all corners, including exposed walls.
1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

A. Mockups
   1. Specify mockups for exposed concrete conditions.

B. Pre-installation meetings
   1. Specify a pre-installation meeting prior to the first structural concrete pour for attendance by the WU PM, structural engineer, construction manager, concrete subcontractor, concrete supplier, and testing agency.
04 43 00

STONE MASONRY

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Stone masonry veneer
   2. Stone fabrications

B. Related sections
   1. Section 32 00 00 “Exterior Improvements”
   2. See the Introduction, Schedules, Figures, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Reference building: Somers Family Hall (Psychology Building) on Forsyth Blvd.
   1. Coursing: Random Ashlar, 11-1/16” course
   2. Nominal stone heights: 10” (10-1/16” actual), 6” (6-3/8” actual), 3” (2-11/16” actual)
   3. Height blend: 20% of 10” height, 55% of 6” height, 25% of 3” height
   4. Color blend: 80% Missouri Red stock, 20% Light Missouri Red stock (This color blend matches McDonnell Hall on Forsyth Blvd. Somers Family Hall used the Bid Alternate identified below.)
   5. Limitations:
      a. Maximum granite stone length: 22”
      b. Maximum horizontal joint length: 6’-0”

B. Indicate on the drawings the following information regarding the veneer design:
   1. Basic coursing module from bottom of stone bed to bottom of stone bed, including the mortar joint
   2. Nominal dimensions of cut granite
   3. Percentage mix of stone sizes as a percentage of wall area
   4. Percentage mix of stone type and color as a percentage of wall area. Discuss with the project team the current range of colors available from potential quarries.

C. Specify mortar in limestone joints except where the joints will encounter expansion and adverse leakage resulting from weathering. Typically, specify limestone joints as follows:
   1. Coping stones: raked and sealant
   2. Water tables: raked and sealant
   3. Profiled string course: raked and sealant
   4. Flat string course, within the plane of the wall: mortar
   5. Window mullions: raked and sealant
   6. Control joints: sealant (1” +/- 1/8” wide)
   7. Arches: raked and sealant
   8. All window-surround limestone: raked and sealant
9. All door-surround limestone: raked and sealant
10. Joint between coping and wall flashing: sealant between coping stone and flashing on both wall faces
11. Extended projections beyond face of the wall: raked and sealant
12. All instances within or recessed behind plane of the wall: mortar

D. Miscellaneous
1. Ensure the design of the stone veneer works to stone coursing and the limestone features work to the coursing without lugging or other modifications.
2. Specify 6'-0" maximum horizontal joint length.
3. Specify grinding of granite to receive all surface mounted devices, including lights, hose bib boxes, Knox boxes, card readers, etc. Specify hand pitching around the device mounting surfaces.
4. Detail coping stones atop parapet walls sloping toward the roof.
5. Specify a mortar mesh at the bottom of wall cavities.
6. Specify weep and vent holes at all wall cavities, bottom and top, to allow for drainage and venting.
7. Coordinate with structural engineer to specify proper anchorage to backup substrate, including stainless steel components within the wall cavity.
8. Specify an integral water repellent for Portland-cement-based mortars at limestone and granite.
9. Do not permit mortar admixtures without design team approval.
10. Do not specify limestone at or near grade.

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

A. Mockups
1. Specify onsite mockups oriented to receive direct sunlight.
2. Preliminary mockups
   a. Assume and specify two preliminary mockups.
   b. Coordinate mockup locations with the project team.
   c. Specify 5’ wide x 6’ tall mockups, minimum.
   d. Specify all details to match project design.
   e. Review preliminary mockup with the WU PM, University Architect, architect, construction manager, masonry contractor, stone fabricator, and stone supplier.
   f. If the first preliminary mockup is not acceptable in every way, provide written direction of required adjustments.
   g. Specify construction of a second preliminary mockup in accordance with the written direction and review with the project team.
3. Final mockup
   a. Specify a final masonry mockup as part of the overall building mockup, including pertinent masonry details, e.g., typical window, coping, outside corner, flashing, weeps, CMU backup, etc.
   b. Specify removal and replacement of all non-conforming work.
   c. The final mockup shall become the standard for stone masonry on the project.

B. Conduct a pre-installation meeting with the WU PM, architect, construction manager, and masonry contractor.
PART 2 PROVIDERS & PRODUCTS

2.1 PRODUCTS

A. Basis of design products

1. Red granite
   a. Missouri Red granite as quarried in Ironton, Missouri.
   b. Develop a Bid Alternate to identify the net cost difference to use a blend of Cold Spring Granite and Granicor matching the blend of the Somers Family Hall.

2. Limestone for portions of building not in contact with grade
   a. Classification: ASTM C 568, Category II (Medium Density)
   b. Other: Oolitic limestone, Smooth machine finish, ILIA Rustic grade, Buff color
   c. Limestone sources: As quarried in Lawrence, Monroe, and Owens counties of Indiana.

3. Limestone for site features and paving
   a. Classification: Type ASTM C 568, Category III (High Density)
   b. Other: Dolomite limestone, Smooth machine finish, Buff color
   c. Limestone sources: As quarried by Valders Stone & Marble

PART 3 EXECUTION – NOT USED
PART 1 GENERAL

1.1 SUMMARY

A. Section includes
1. Structural & miscellaneous steel
2. Architecturally exposed structural steel (AESS)
3. Steel joists
4. Steel decking

B. Related sections
1. Section 10 21 00 “Toilet Compartments”
2. Section 11 89 21 “Facility Fall Protection”
3. Section 14 20 00 “Elevators”
4. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Structural & miscellaneous steel
1. Provide floor and roof loading diagrams on the project drawings.
2. Specify all exterior steel be hot dipped galvanized.
3. Gratings
   a. Specify all grating and grating support. Do not delegate the design.
   b. If grating is required in public areas, design grating and grating support for L/360 live load deflection, minimum.
   c. Specify hot dipped galvanized grating for all applications.
4. Specify round or square steel sections for roof penetrations to simplify roof flashings.
5. Steel angles with headed studs embedded into concrete walls often conflict with concrete formwork. Design a steel angle field welded to an embed plate with headed studs for this condition.
6. WU prefers elevator guiderails capable of spanning floor to floor without the use of backup steel. Coordinate guiderail sizes and embed requirements with elevator manufacturer.
7. Review extents of typical details with WU and the design team to evaluate the impact of non-modeled elements (e.g., kickers, top bracing of CMU walls) which may conflict with other work.
8. Design structural support of ceiling hung toilet partitions.
9. WU accepts reasonable sloping of structural roof members, but prohibits warping all bays of framing to create roof slopes to drain. Utilize tapered insulation to create drainage planes.

B. Architecturally exposed structural steel (AESS)
1. Do not specify AESS without approval of the WU PM.
2. For conditions requiring a higher finish level, review design objectives with standard practices of local/selected fabricator.
C. Steel joists
   1. Specify joists to be designed for an additional 500 lb. concentrated load at any location along the top or bottom chords.
   2. Specify joist tags to include joist designation.

D. Steel decking
   1. Specify 20 gauge minimum steel decking.

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

A. Regulatory requirements
   1. Comply with FM Global requirements for the specification of roof deck and attachment.

B. Meetings
   1. Specify a pre-construction meeting with WU, structural engineer of record, steel connection engineer of record, fabricator, and construction manager prior to the first structural steel submittal.

PART 2 PROVIDERS & PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED
WATERPROOFING

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PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Waterproofing at vertical and horizontal surfaces

B. Related sections
   1. 02 30 00 “Geotechnical & Testing Services”
   2. 22 14 00 “Facility Storm Drainage”
   3. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Vertical surfaces
   1. Specify 60-mil min. modified bituminous sheet waterproofing and drainage panel.
   2. Discuss with the project team at the SD phase the specific strategy and details to prevent migration of fine soil particles into the drainage panel.
   3. Discuss with the project team at the SD phase the specific strategy and details associated with typical foundation wall waterproofing, including waterproofing details at wall and footing, location of foundation drain tile, native soil cut plane/angle, geotextile fabric location, and backfill material requirements.

B. Horizontal surfaces
   1. Specify hot fluid-applied rubberized asphalt waterproofing and drainage panel.
   2. Discuss with the project team at the SD phase the specific strategy and details to prevent migration of fine soil particles into the drainage panel, including a soil profile containing choker grit and sands above the drainage panel.

C. Specify self-expanding butyl strip waterstop at all intersections of subgrade walls and floors.

D. Specify Xypex admixtures for walls and floors of elevator and mechanical pits.

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

A. Specify a 10 year, non-prorated manufacturer’s warranty and a three-year installer’s special warranty.
PART 2 PROVIDERS & PRODUCTS

2.1 PRODUCTS

A. Basis of design products
   1. Vertical surfaces
      a. Waterproofing: Carlisle CCW MiraDRI 860/861
      b. Drainage panel: Carlisle MiraDrain 9800
   2. Horizontal surfaces:
      a. Waterproofing: Carlisle CCW-500R
      b. Drainage panel: Carlisle MiraDrain 9000
   3. Self-expanding butyl waterstop: Carlisle MiraSTOP

PART 3 EXECUTION – NOT USED
07 30 00

ROOFING

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PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Roofing systems, accessories and associated components
   2. Roof requirements for solar installations

B. Related sections
   1. Section 11 89 20 “Facility Fall Protection”
   2. Section 22 14 00 “Facility Storm Drainage”
   3. Section 26 30 00 “Facility Electrical Power Generating & Storage Equipment”
   4. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Specify FM Global compliant roof systems.

B. Slate roofing
   1. Select slate quarries and products per Part 2 which produce slate consistent with slate previously used on the WU campus. Confirm acceptability prior to selection.
   2. Specify waterproofing underlayment, 40 mil min. Detail underlayment to extend 6” minimum higher than top of adjacent parapet wall or roof overflow drain.
   3. Specify 11 gauge nails, hard copper, 3/8” diameter head, minimum.
   4. Specify snow guards if no parapet is present.
   5. Specify a 4’x4’ minimum mockup for slate roofing.

C. Membrane roofing
   1. WU prefers 1/4” per 12” slope, minimum.
   2. Specify 60 mil. minimum, white, non-reinforced EPDM membrane.
      a. Specify mechanically fastened roofing over metal deck and wood.
      b. Specify fully adhered attachment roofing over concrete.
      c. Typically, specify extruded polystyrene board insulation. Polyisocyanurate insulation is acceptable where required to obtain fire-rated assemblies.
   4. Specify 1/2” minimum insulation protection board installed with low-rise urethane adhesive.
   5. Roof protection
      a. Specify manufacturer’s standard walkway pad for anticipated foot traffic to and around mechanical equipment, roof drains, and other equipment requiring maintenance.
      b. Specify an 80 mil slip sheet, 4” larger minimum on all sides, below all roof blocks, equipment feet, or other ballasted equipment.
6. Specify termination bars at all vertical and horizontal terminations.
7. Specify adhesive or tape splices.
8. Specify continuous fabric wall and curb flashings where possible and cured EPDM flashings where continuous fabric is not possible.
9. Specify tapered roof insulation rather than warping structural members to provide drainage.
10. WU accepts localized reduction of insulation thickness at roof drains to allow greater slopes to prevent ponding.

D. Roof accessories
1. Specify 3’x4’ minimum roof hatch.
2. Specify manual wheel/pull and locking assembly located at floor or landing.
3. Specify perimeter railings and a self-closing gate at all roof hatches.
4. WU prefers ships ladders over vertical ladders to access roof hatches.

E. Coordination items for concurrent or future solar photovoltaic (PV) installations
1. Design all flat roofs to be PV ready per the requirements in the related sections.
2. Specify an 80 mil TPO slip sheet below all solar PV equipment (legs, conduit blocks, inverters, etc.).
3. Specify roof walkway pads to accommodate concentrated foot traffic created by the PV system.

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

A. Quality control
1. Require manufacturer-certified roofing installers.
2. Specify a roof flood test utilizing 2” minimum standing water after completion of the roof membrane and related flashing which maintains the water level for 48 hours minimum.

PART 2 PROVIDERS & PRODUCTS

2.1 MANUFACTURERS

A. Basis of design products and manufacturers
1. Slate roofing
   a. Slate manufacturers
      1) Evergreen Slate Co., Granville, NY
      2) Vermont Structural Slate Co., Fair Haven, VT
   b. Type: 20” long x random width 10”-14”
   c. Texture: Rough texture
   d. Nominal thickness: 1/4”-3/8”
   e. Color: Unfading Green
2. Snow guards
   a. MJ Mullane Co., #100S
   b. Zaleski Snow Guards, #4
3. Membrane roofing: Carlisle, Firestone, Johns Manville

PART 3 EXECUTION – NOT USED
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PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Firestopping

B. Related sections
   1. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Specify re-penetrable firestopping devices along IT pathways.

B. Specify identification of penetration and joint firestopping systems with legible metal or plastic labels, permanently attached to surfaces adjacent to and within 6 inches of joint or penetration so labels are visible to anyone seeking to replace firestopping.

PART 2 PROVIDERS & PRODUCTS

2.1 PRODUCTS

A. Basis of design product
   1. EZ-Path

PART 3 EXECUTION – NOT USED
The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Doors and frames

B. Related sections
   1. Section 08 71 00 “Door Hardware”
   2. Section 08 80 00 “Glazing”
   3. Section 09 90 00 “Painting”
   4. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Doors
   1. Specify 3'-0" wide x 7'-0" high x 1-3/4" thick doors. Review any exceptions with the WU PM.
   2. Specify flush tops on exterior hollow metal door tops to eliminate trapped water and debris.
   3. Specify flush tops on interior hollow metal doors in “clean” environments.
   4. Specify an appropriate insulating core and seals for interior doors used for acoustical isolation.
      Review with WU PM the specific STC rating requirements and mitigation measures.

B. Frames
   1. Specify welded hollow metal frames at all locations except residential occupancies.
   2. Specify knockdown frames only when approved by WU PM due to project-specific circumstances.
   4. Specify taller heads on hollow metal frames in CMU walls to align with coursing. Do not specify non-
      typical door heights.

C. Miscellaneous
   1. Specify standard duty doors and frames per ANDI/SDI A250.8, Level 1, unless noted otherwise.
   2. Specify heavy duty doors and frames in all exterior locations and in select interior locations subject
      to cart and service traffic, per ANSI/SDI A250.8, Level 2.
   3. Specify factory primed frames and doors. WU allows but does not require a factory finish.

PART 2 PROVIDERS & PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED
08 40 00

ENTRANCES, STOREFRONTS, & CURTAIN WALLS

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1  GENERAL

1.1 SUMMARY

A. Section includes
1. Aluminum entrances, storefronts, and curtain walls

B. Related sections
1. Section 01 81 13 “Sustainable Design Requirements”
2. Section 08 71 00 “Door Hardware”
3. Section 08 80 00 “Glazing”
4. Section 28 00 00 “Electronic Safety & Security”
5. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Procurement
1. Prepare a Curtain Wall early bid package and issue at completion of Design Development for use by the Construction Manager in selecting a manufacturer and product type. Coordinate with the manufacturer in a design-assist relationship and incorporate the manufacturer’s details into the design team’s building details through Construction Documents.
2. Specify one manufacturer if a project utilizes both storefront and curtain wall systems.

B. Specify pressurized water infiltration testing of installed system for exterior storefront and curtain wall systems.

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

A. Mockups
1. Specify mockups for storefront and curtain wall systems which include a typical section of storefront or curtain wall framing, a fixed glazing panel, and a typical entrance.

1.4 WARRANTY, START UP, COMMISSIONING, & MAINTENANCE REQUIREMENTS

A. Special warranty
1. Specify a manufacturer’s written warranty for entrance and storefront systems, covering repair or replacement of any system which leaks, or exhibits defects in materials, finish, or operation, within 10 years from date of substantial completion.
2. Specify a manufacturer’s written warranty for the polyvinylidene fluoride enamel finish assigned specifically to project, covering film integrity (including chipping, crazing, pitting, and delamination),
chalk resistance, color fading, and color change, within 10 years from date of substantial completion.

PART 2 PROVIDERS & PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED
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PART 1 GENERAL

1.1 SUMMARY

A. Section includes

1. Aluminum windows

B. Related sections

1. Section 01 81 13 “Sustainable Design Requirements”
2. Section 08 80 00 “Glazing”
3. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Operation & frame dimensions

1. Specify single-hung sash windows with operable lower sash and fixed upper sash, typical.
2. Typical operable frame nominal dimensions:
   a. Frame depth: 3-1/4”
   b. Head profile: 2-7/8”
   c. Horizontal meeting rail profile: 2”
   d. Sill profile: 2-5/8” + 1/2” receiver
   e. Jamb profile: 2-7/8”
   f. Vertical intermediate mullion: varies

B. Materials

1. Specify 0.125” thick minimum aluminum extrusions for main frame and sash members.
2. Finish
   a. Typical window color: Wausau Revere Gray M743
   b. Specify superior-performance organic finish (two-coat fluoropolymer) thermocured system with no less than 70% polyvinylidene fluoride resin by weight, similar to Kynar 500 by Arkema, Inc.
   c. Specify a bid alternate for factory-applied modified acrylic or polyester enamel high-performance organic coating meeting the requirements of AAMA 2604.

C. Performance requirements

1. Structural
   a. Specify industry standard deflection requirements, unless noted otherwise.
   b. When window mullions are used as structural backup for stone mullions, ensure associated window mullion deflection is less than L/600, min.

2. Specify window systems capable of withstanding thermal movements resulting from an ambient temperature differential of 120°F (which may result in a metal surface temperature range of 180°F
within the window framing) without causing buckling, glass stresses, joint sealant failure, fastener
damage, or other detrimental effects.
3. Specify window systems with a thermal-break construction tested in accordance with AAMA 1502.7
and certified by the manufacturer to provide a condensation resistance factor (CRF) of 60.
4. Specify windows at ground level compliant with AAMA 1302.5 “Voluntary Specifications for Forced
Entry Resistance Aluminum Prime Windows.”
5. Miscellaneous
   a. Specify stainless steel fasteners to attach windows to substrates.

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS
   A. Mock-ups
      1. Include one typical, approved window installed, flashed, and sealed with approved materials in the
         exterior wall mockup.

1.4 WARRANTY, START UP, COMMISSIONING, & MAINTENANCE REQUIREMENTS
   A. Special warranty
      1. In addition to the window manufacturer’s standard written warranty for materials and
         workmanship, specify a special 10-year warranty for the work specified in this Section warranting
         that the windows and installation are free from defects in materials, performance, and installation,
         including:
            a. Glass breakage
            b. Failure of operational parts to function normally
            c. Deterioration or discoloration of finish
            d. Failure of the system to meet performance requirements

PART 2 PROVIDERS & PRODUCTS

2.1 MANUFACTURERS
   A. Basis of design manufacturers
      1. Specify aluminum windows from the following manufacturers:
         a. Efco Corp.
         b. Manko Window Systems, Inc.
         c. Wausau Metals Corporation
         d. Winco Manufacturing Co.

PART 3 EXECUTION – NOT USED
08 71 00

DOOR HARDWARE

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1  GENERAL

1.1 SUMMARY

A. Section includes
   1. Locksets and latchsets
   2. Cylinders, including cylinders for door hardware specified in other sections
   3. Keying
   4. Hinges
   5. Electrified door hardware
   6. Coordination with Access Control devices provided by WU’s sole source security provider

B. Related sections
   1. Section 08 10 00 “Door & Frames”
   2. Section 08 40 00 “Entrances, Storefronts & Curtain Walls”
   3. Section 28 10 00 “Electronic Safety & Security”
   4. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS:

A. Locksets and latchsets
   1. Specify cylindrical locksets and latchsets for light- and medium-frequency doors.
   2. Specify mortise locksets and latchsets for entrances and other high-frequency doors.
   3. Specify intruder function locksets at offices, meeting rooms, conference rooms, instructional spaces, and other locations deemed appropriate by WU FPM.

B. Cylinders
   1. For projects with 20 doors or fewer, specify cylinders as OPOI through WU PM and WU Lockshop.
   2. For all other projects, specify cylinders as CFOI.

C. Keying
   1. Specify the hardware supplier to coordinate with WU to furnish properly identified key cores.
   2. For all locks and keyed cylinders, provide the following:
      a. (1) core
      b. (2) keys

D. Hinges
   1. Specify 4-1/2” x 4-1/2” full mortise hinges for 1-3/4” thick doors, typical.
   2. Specify ball bearing hinges for all doors with closers, all doors 7’ or more in height, all doors with medium or high frequency usage, and all rated openings.
   3. Specify 4 wires minimum at electric through-wire (ETW) hinges. ETW hinges are acceptable at interior doors with full mortise hinges.
E. Concealed electric power transfers (CEPT)
   1. Specify four (4) wires, minimum.
   2. CEPTs are acceptable at exterior doors, interior doors with pivots, and interior doors with high frequency usage.

F. Sliding doors
   1. Specify mechanical locking devices. Electronic access control is not acceptable.

G. Finishes
   1. New construction:
      a. For smaller renovations or additions, match hardware finish of existing facility.
      c. Interior, alternate: Specify US 10B / 613-640 (oil-rubbed bronze) as appropriate.
   2. For exterior door openings in new construction with stainless steel hardware and devices, specify US32D/630 (satin stainless steel).
   3. For exterior wood doors in collegiate gothic exteriors, specify US 10B / 613-640 (oil-rubbed bronze).

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS
A. Include a Door Opening schedule and Door Hardware schedule in contract documents.
B. Specify door hardware and devices for openings in rated assemblies that bear UL listing labels.

PART 2 PROVIDERS & PRODUCTS

2.1 PREFERRED STAND-ALONE LOCK PROVIDERS
A. A-1 Corporate Hardware
   800-368-2348
   www.a-1lock.com
   Lauren Magnen

2.2 PRODUCTS
A. Specify the following basis of design manufacturers and products
   1. Cylinders: Best Lock Corporation series 1E (no substitutions)
   2. Cylindrical locksets and latchsets: Best Lock Corporation series 9K (no substitutions)
   3. Mortised locksets and latchsets: Best Lock Corporation series 45H (no substitutions)
   4. Intruder-function cylindrical locksets: Best Lock Corporation 9K37AB15DS3 (no substitutions)
   5. Intruder-function mortised locksets: Best Lock Corporation 45H7UNR15H (no substitutions)
   6. Exit devices: Von Duprin 98/99 series (no substitutions)
   7. QEL exit devices: Von Duprin 98/99 series (no substitutions)
   8. Privacy deadbolts: Best, Schlage
   9. Hinges: Hager, Stanley, McKinney
   10. ETW hinges: Hager, Stanley, McKinney
   11. Pivots: Rixson, Hager, McKinney, Stanley
   12. Concealed Electric Power Transfer (CEPT): Securitron CEPT-10 (no substitutions)
   13. Surface closers: LCN Smoothee 4000 Series (no substitutions)
14. Magnetic holders: Rixson 990 Series
15. Magnetic locks: SDC Hi/Shear Emlock 1500 series
16. Other devices: Architect’s option. Review selections with WU.
17. Stand-alone locks at IT closets: Schlage AD 250 battery operated card reader lockset.

PART 3 EXECUTION – NOT USED
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PART 1 GENERAL

1.1 SUMMARY

A. Section includes
1. Glazing for windows, storefront, curtain wall and interior glazing

B. Related sections
1. Section 01 81 13 “Sustainable Design Requirements”
2. Section 08 40 00 “Entrances, Storefronts, & Curtain Walls”
3. Section 08 50 00 “Windows”
4. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Glass types may include, but are not limited to, heat-strengthened, tempered, fire-resistive, wire glass and other types of special glazing as necessary. Review all applications with WU PM.

B. Prior to specification of heat-soaked glazing products, consult with WU PM. Use of heat-soaked glazing products may require an extended warranty period.

C. Do not specify etched interior glazing. Coordinate with WU PM to determine locations of decorative glazing film after building occupancy.

1.3 WARRANTY, START UP, COMMISSIONING, & MAINTENANCE REQUIREMENTS

A. Special warranty
1. In addition to material manufacturer’s standard warranties for all materials, specify a 10-year warranty against seal failure for insulating glass units.

PART 2 PROVIDERS & PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED
CEILINGS

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY
   A. Section includes
      1. Ceilings
   B. Related sections
      1. Appendix 01 “WU Seismic Site Classification”
      2. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS
   A. Typical installations (administration areas, offices, classrooms, seminar rooms, lecture halls, etc.)
      1. Specify 2’ x 2’ grid spacing, 9/16” exposed tees, baked enamel, off-white finish. Do not specify 2’ x 4’ grid spacing.
      2. Specify fine-textured, tegular-edge, lay-in panels with relatively high LRC, CAC, STC, and NRC ratings.
   B. Exposed ceilings
      1. Review specific requirements for exposed structure, MEPFP equipment, conduit, and connections, and any other exposed ceiling components with the WU PM during the design development phase.

1.3 WARRANTY, START UP, COMMISSIONING, & MAINTENANCE REQUIREMENTS
   A. Specify contractor to provide attic stock to WU prior to final completion.
      1. Ceiling panels: 2% of the gross ceiling area, 1 carton of each type of ceiling panel used, min.
      2. Hold-down clips: 5% of the number installed

PART 2 PROVIDERS & PRODUCTS

2.1 PRODUCTS
   A. Specify products from the following manufacturers:
      1. Armstrong Commercial
      2. Chicago Metallic Corp.
      3. USG

PART 3 EXECUTION – NOT USED
09 60 00
FLOORING

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1  GENERAL

1.1 SUMMARY

A. Section includes
   1. Linoleum flooring
   2. Resinous flooring
   3. Terrazzo flooring
   4. Tile carpeting

B. Related sections
   1. Section 01 81 13 “Sustainable Design Requirements”
   2. Section 03 00 00 “Concrete”
   3. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. General
   1. Submit all flooring materials, accessories, and installation methods to WU PM for review.
   2. Do not specify polished concrete floors due to poor past performance, including variances between “field” and “edge” polishing techniques and random cracking/crazing.
   3. Specify chemical-resistant materials for laboratory, foodservice, and bathroom locations.
   4. Specify welded seams at all locations where resilient flooring is used.
   5. Specify moisture mitigation where adhered flooring is installed.

B. Typical flooring selections by space type
   1. Specify carpet tiles for administrative areas, offices, conference rooms, and supporting spaces.
   2. Specify epoxy resin, resilient sheet flooring, or resilient tile flooring for laboratory spaces.
   3. Specify epoxy resin, quarry tile, or resilient sheet flooring for foodservice spaces.
   4. Specify terrazzo or porcelain tile for bathrooms.

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

A. Specify mockups for projects over $5 million. Confirm with WU PM.

PART 2 PROVIDERS & PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED
09 90 00

PAINTING

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Interior and exterior paint systems

B. Related sections
   1. Section 01 81 13 “Sustainable Design Requirements”
   2. Section 08 10 00 “Doors & Frames”
   3. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Specify exterior painting as follows:
   1. Ferrous metal: Hot-dipped galvanizing, primer, 2 coats semi-gloss urethane finish
   2. Wood trim: Primer, 2 coats exterior acrylic latex semi-gloss

B. Specify interior painting as follows:
   1. Ferrous metal, including doors and frames: Rust-inhibiting primer, 1 coat enamel undercoat, 1 topcoat acrylic latex semi-gloss
   2. Gypsum board walls: Primer, 2 coats acrylic latex eggshell
   3. Plaster: Primer, 2 coats acrylic latex eggshell
   4. Exposed concrete floor: 2 coats clear epoxy
   5. CMU: Block filler, 2 coats acrylic latex semi-gloss
   6. Wood, doors and trim: Primer, 2 coats acrylic latex semi-gloss
   7. Architectural woodwork, opaque finish: Primer, 2 coats acrylic latex semi-gloss
   8. Architectural woodwork, transparent finish: 1 coat water-based stain, 2 coats polyurethane

PART 2 PROVIDERS & PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED
TOILET COMPARTMENTS

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Solid plastic toilet compartments configured as toilet enclosures and urinal screens.

B. Related sections
   1. Section 05 00 00 "Structural and Other Steel"
   2. Section 10 28 00 "Toilet Accessories"
   3. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Toilet compartments
   1. Specify HDPE panel material, 1” thick minimum.
   2. Specify ceiling hung toilet enclosures.
   4. Door size and swings
      a. Specify 24” wide in-swinging doors for standard toilet compartments.
      b. Specify 36” wide out-swinging doors with a minimum 32” wide clear opening for accessible compartments.

B. Bracket types
   1. Specify stainless steel or aluminum continuous type brackets at toilet compartments.
   2. Specify stainless steel or aluminum stirrup type brackets at urinal screens.

C. Hardware
   1. Specify manufacturer’s stainless steel, heavy-duty operating hardware and accessories.
   2. Specify through bolt mounting for all hardware.
   3. Hinges
      a. Specify cam type hinges that swing to a closed or partially open position and allow emergency access by lifting door.
      b. Specify hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched.

1.3 WARRANTY, START UP, COMMISSIONING, & MAINTENANCE REQUIREMENTS

A. Specify 20% attic stock of the following items matching installed products. Require the contractor to protect, label, and turn over material to WU prior to final completion.
   1. Door hinges
2. Latch and keeper
3. Door bumper
4. Door pull
5. Fasteners

PART 2 PROVIDERS & PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED
TOILET ACCESSORIES

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PART 1  GENERAL

1.1 SUMMARY

A. Section includes
   1. Toilet accessories, including items serviced by WU’s custodial contractor.

B. Related sections
   1. Section 10 21 00 “Toilet Compartments”
   2. See the Introduction, Schedules, Figures, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS:

A. Design restrooms to allow for placement of OFOI free-standing waste receptacle near the door. Utilize Rubbermaid Slim Jim waste receptacle for design coordination.

B. Designate toilet accessories required in this section as OFCI in the contract documents.

C. Specify recessed or semi-recessed accessories to the greatest extent possible.

D. WU discourages the specification of recessed, combination Paper Towel Dispensers/Waste Receptacles due to capacity limitations for high-volume restroom usage.

E. Specify a sink, refrigerator, bench, soap dispenser, and paper towel dispenser in lactation rooms.

PART 2 PROVIDERS & PRODUCTS

2.1 PRODUCTS
### A. Sink and shower accessories

<table>
<thead>
<tr>
<th>Item</th>
<th>Manufacturer</th>
<th>Model</th>
<th>Model #</th>
<th>Finish</th>
<th>Power</th>
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<tbody>
<tr>
<td>Paper Towel Dispenser</td>
<td>Georgia Pacific</td>
<td>GP PRO enMotion Impulse 10”</td>
<td>59447A</td>
<td>White</td>
<td>Hard wired</td>
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<td></td>
<td></td>
<td>GP PRO enMotion 10”</td>
<td>59407A</td>
<td>White</td>
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<tr>
<td></td>
<td></td>
<td>GP PRO enMotion Impulse 10”</td>
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<td>GP PRO enMotion 10”</td>
<td>59462A</td>
<td>Black</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>GP PRO enMotion</td>
<td>59466A</td>
<td>Stainless</td>
<td>(semi-recessed)</td>
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<td></td>
<td>Stainless Surface Mount Collar Accessory for Item #59466A: Model #605192</td>
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<td></td>
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<tr>
<td>Soap Dispensers,</td>
<td>Georgia Pacific</td>
<td>GP PRO enMotion Gen2</td>
<td>52058</td>
<td>White</td>
<td>Battery</td>
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<td>Wall Mounted</td>
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<td>52060</td>
<td>Stainless</td>
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<td>Soap Dispensers,</td>
<td>Georgia Pacific</td>
<td>Pacific Blue Ultra</td>
<td>53058</td>
<td>White</td>
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<td>53060</td>
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### B. Toilet compartment accessories

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<tr>
<th>Item</th>
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<th>Model</th>
<th>Model #</th>
<th>Location</th>
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<tbody>
<tr>
<td>Toilet Paper Dispensers</td>
<td>Bobrick</td>
<td>Surface Mount Twin Jumbo-Roll</td>
<td>B-2892</td>
<td>Public Restrooms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface Mount Single Jumbo-Roll</td>
<td>B-2890</td>
<td>Gender Neutral/Single User Restrooms</td>
</tr>
<tr>
<td>Toilet Seat Cover Dispenser</td>
<td>Bobrick</td>
<td>Surface Mounted</td>
<td>B-221</td>
<td>All</td>
</tr>
<tr>
<td>Sanitary Napkin Disposal</td>
<td>Bobrick</td>
<td>Surface Mounted, Wall</td>
<td>B-270</td>
<td>Public Women’s Restrooms/Gender Neutral/Single User Restrooms</td>
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<td></td>
<td>Surface Mounted, Toilet Compartment Partition</td>
<td>B-354</td>
<td>Preferred Mounting Location</td>
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<tr>
<td>Baby Changing Station</td>
<td>Koala Kare</td>
<td>KB200-01</td>
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<td>Restrooms near public use areas</td>
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LABORATORY EQUIPMENT

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Laboratory equipment and related items

B. Related sections
   1. Division 22 Plumbing Sections for supply to and waste piping from laboratory equipment
   2. Division 23 Mechanical Sections for make-up air, exhaust, and coord. with other mechanical req’ts
   3. Division 26 Electrical Sections for supply to laboratory equipment
   4. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

1. Fume hoods
   a. Programming
      1) The design team, including architect, MEP engineers, and lab designers shall consult with the WU PM, WU Environmental Health & Safety, department lab managers, and individual PIs for input related to fume hoods.
      2) Review programmatic requirements with end users. Verify basic and detailed fume hood and laboratory ventilation requirements with user.
      3) Safe and reliable operation of fume hoods are the primary design objectives.
         a) Do not locate fume hoods along traffic paths. The preferred location for fume hoods is along and at the end of dead-end pathways.
         b) Ensure that no physical items (e.g., pipes, conduits, ductwork, lights, ceilings, etc.) are located above the sash which would inhibit full operation of the sash.
         c) Carefully specify and locate HVAC air diffusers per engineering requirements to avoid interference with hood operation caused by air flow from the diffusers and dead spots in the space.
      4) Specify ADA compliant fume hoods only where determined to be required during the programming phase.
      5) Evaluate and review with WU the level of diversity, redundancy, and additional capacity in the HVAC design.
      6) Verify the HVAC design (e.g., external fume hood exhaust location) is compatible with anticipated fume hood use and complies with applicable laws, codes and ordinances.
      7) Verify that duct materials, fans, and other building systems are compatible with anticipated fume hood use.
      8) Verify MEP documents indicate rough-ins for all required utilities.
      9) Verify fume hood exhaust straight duct lengths comply with manufacturer’s written requirements.
10) Indicate on construction documents whether each fume hood is VAV or constant volume.
11) Consult with WU PM to conduct campus level air flow modeling to evaluate impact of building lab exhaust on subject and adjacent buildings.

b. Containment & air flow
1) Specify fume hoods which, at a minimum, meet Scientific Equipment and Furniture Association (SEFA) energy efficient characteristics unless WU specifically reviews and approves in writing.
2) Specify fume hoods utilizing a combination sash without gaskets.
3) Typical fume hoods shall operate at 70 fpm.
4) Non-typical fume hoods shall operate between 70-100 fpm.
5) Design fume hood airflow volumes for the criteria in each of the following positions at the respective hood face velocity rate:
   a) Horizontal sash full open with glass in any position with an upper valance for a 28” minimum vertical opening. Specify a 6” high clear operable panel integrated into the top of the sash. Alternatively, specify a user-removable 6” high clear static panel at the top of the sash opening.
   b) Vertical sash approximately half-open. Determine actual stop position by balancing for the face velocity for the horizontal, full open position, and then setting the vertical stop to achieve equal face velocity without adjusting the balance settings. Note: Vertical sash stop position shall not be lower than 14 inches.
6) The pressure drop for 4’, 6’, and 8’ bench and floor-mounted fume hoods shall not exceed 0.25” w.g. and the pressure drop for fume hoods larger than 8’ shall not exceed 0.50” w.g. Evaluate this pressure drop requirement at the duct collar with the face velocity design criteria through 50% of sash area (half open vertical sash).
7) Require the manufacturer to indicate the specific CFM requirements for each fume hood to produce the 70 fpm flow requirement specified above.

c. Architectural
1) Standard working surface height shall be 36”.
2) Specify fixed baffles unless adjustable baffles are requested by the Department, EH&S, and WU PM.
3) Cable and pulley sash systems are acceptable.
4) Specify or confirm fume hoods utilize laminated safety plate glass.
5) Specify loose sash height limiting hardware for field installation by contractor.
6) Countertops
   a) Specify black, 1-1/4” thick, dished epoxy resin countertops
   b) Coordinate with the Department, EH&S, and WU PM for quantity & locations of cup sinks in countertops.
   c) Specify traps furnished under Division 22 Plumbing.
7) Typically, specify base cabinets with the building casework package.
   a) Acid resistant storage cabinet
      i. Specify cabinet with two compartments to isolate the cup sink/trap assembly from the line portion of the cabinet. Specify 12”x12” maintenance compartment, minimum.
      ii. Specify white polypropylene lining on all metal surfaces.
      iii. Specify 1-1/2” dia. vent pipe connecting two points (high and low) at the rear of base cabinet to the inside hood chamber behind the baffle plate and sealed. Detail vent pipe to extend 12” above fume hood countertop.
      iv. Specify a removable back panel.
      v. Do not specify self-closing doors.
vi. Specify adjustable plastic shelves supported with locking clips to avoid inadvertent removal of shelf.

vii. Specify shelves capable of supporting 150 lbs. without deflection.

viii. Specify (1) 1" deep, white, polypropylene, liquid-tight drip pan to cover the entire floor area of the lined cabinet compartment.

ix. Specify all fasteners and shelf supports to be plastic.

x. Specify hardware to be non-corrodible.

xi. Specify signage on cabinet doors indicating "CORROSIVE CHEMICALS"

b) Flammable storage compartments

i. Flammable storage compartments may require venting. Confirm with Department, EH&S, and WU PM.

ii. Conform to NFPA 30 for grounding, grounding screws, and connection to the building grounding system.

iii. Design venting system to connect into exhaust duct system provided under Division 23 HVAC.

iv. Specify a removable back panel.

v. Specify adjustable expanded metal shelves supported with locking clips to avoid inadvertent removal.

Vacuum pump cabinets

i. Design vacuum cabinet to match standard cabinets with the addition of 1” sound insulating foam, or similar, as an interior liner on walls, back, top, and doors. Specify mechanical attachment of insulation.

ii. Specify means for cabinet ventilation.

iii. Specify a rear receptacle.

iv. Specify a removable back panel for service when required. Specify a switch to operate the receptacle located on the inside of the cabinet at cabinets with a false panel.

v. Specify a lipped, pullout shelf or rolling cart for pump removal.

vi. Design accommodations for vacuum lines, low pressure lines, and similar items.

d. Alarms & controls

1) See Part 2 for controls and alarms.

2) Specify thru wall sensors to provide a secondary measure of face velocity measurement and alarm.

3) Specify coordination of the alarm set point and field calibration of devices after commissioning of building exhaust system.

4) Specify field installation of fume hood monitors, thru wall monitors, and sash position sensors.

e. Services

1) Specify fume hoods pre-piped for the following services, minimum:
   a) Engineering: Air, vacuum, two generic gas services
   b) Chemistry: Air, vacuum, two generic gas services
   c) Discuss additional pre-piping needs on a project specific basis.

2) Specify industry standard color coding and lettering for index buttons mounted in fixture handles.

3) Coordinate construction documents to indicate final connections to fume hood by relevant trade contractor. See Divisions 22, 23, and 26.

4) Specify all fixtures that serve special gases (N2, O2, NO2, etc.) and instrument air are lubricated, cleaned, capped, protected, and delivered certified for “Oxygen” service.
f. Electrical
   1) Specify LED light fixtures sufficient to produce 80 foot candles of illumination at working surface of hood.
   2) Specify 120V 20A electrical fixtures prewired to a single junction box, complete with enclosure boxes, receptacles, and cover plates.

g. HVAC
   1) Specify 316 stainless steel or non-ferrous duct collars where required.

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

A. Submittals
   1. Require manufacturers to submit test data indicating compliance with ASHRAE 110 and the “High Performance Laboratory Fume Hood Test Performance Criteria” table below.
   2. Require manufacturers to include fume hood interior volume on shop drawings.

B. Regulatory requirements
   1. Specify the entire hood and fixtures within carry a UL listing.

C. Mockups
   1. Specify a fume hood mockup constructed in a WU facility for evaluation by project stakeholders for new buildings or gut renovations.

PART 2 PROVIDERS & PRODUCTS

2.1 PRODUCTS

A. Fume hoods
   1. Specify fume hood manufacturers and models from the list below:
      a. LabConco – Protector XStream or Protector XL
      b. Kewaunee – Supreme Air
      c. Thermo Scientific – Hamilton SafeAire II
   2. Utilize a LabConco fume hood as the basis of design product.

B. Specify control valves as follows:
   1. Phoenix Controls – Venturi style valves (no substitutions)

C. Specify alarms as follows:
   1. Phoenix Controls – Sentry SE with thru wall sensor (no substitutions)

PART 3 EXECUTION – NOT USED
High Performance Laboratory Fume Hood Test Performance Criteria
Per ASHRAE 110-2016 unless modified herein

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description/Configuration</th>
<th>As Manufactured(^1)(^2) (AM)</th>
<th>As Installed (AI)</th>
<th>As Used (Annual Test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross Draft Velocity</td>
<td>Vertical Sash Design Height</td>
<td>Measured velocity ≤ 30 FPM within 18&quot; from hood face at room airflow design conditions</td>
<td>Modify room air flow if measured velocity exceeds 30 FPM within 18” from hood face</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Horizontal Sash Max Center</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Face Velocity</td>
<td>Vertical 100%</td>
<td>60 FPM (if full sash sensing ability at 100% open)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Vertical Sash Design Height</td>
<td>60 FPM &lt; 10% variation from ave.</td>
<td>70 FPM &lt; 10% variation from ave.</td>
<td>70 FPM &lt; 10% variation from ave.</td>
</tr>
<tr>
<td></td>
<td>Horizontal Sash (Left, Center, Right)</td>
<td>± 10% for any single point from target design face velocity</td>
<td>± 10% for any single point from target design face velocity</td>
<td>± 20% for any single point from target design face velocity</td>
</tr>
<tr>
<td>VAV Face Velocity Control</td>
<td>Closed sash to Operating height in 25% increments; Operating height to Closed sash in 25% increments</td>
<td>Steady state value ± 10% of design</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Exhaust Flow</td>
<td>Vertical Sash Design Height</td>
<td>Design flow ± 5% to achieve average face velocity criteria</td>
<td>Design flow ± 5% to achieve average face velocity criteria</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Horizontal Sash Max Center</td>
<td>Sashes closed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vertical Sash Design Height</td>
<td>Hood static pressure ≤ 0.5” w.g.</td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Horizontal Sash Max Center</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAV Response and Stability</td>
<td>Vertical Sash Design Height</td>
<td>Speed of response ≤ 5 seconds</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Horizontal Sash Max Center</td>
<td>Time to steady state ≤ 5 seconds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airflow Visualization (smoke)</td>
<td>Vertical 100% Open</td>
<td>No visible escape beyond plane of sash.</td>
<td>VAV hoods shall undergo additional challenge by raising and lowering sash. Smoke observed beyond plane of sash when generated 6” inside plane of sash fails the test.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vertical Sash Design Height</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Horizontal Sash Max (Left, Center, Right)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## High Performance Laboratory Fume Hood Test Performance Criteria (continued)

Per ASHRAE 110-2016 unless modified herein

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description/ Configuration</th>
<th>As Manufactured(^1) (AM)</th>
<th>As Installed (AI)</th>
<th>As Used (Annual Test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0 Lpm SF(_6) Tracer Gas Containment(^3,4) (Static Mannequin, 3 test positions)</td>
<td>Vertical 100% Open</td>
<td>5 min ave. &lt; 0.05 ppm Peak &lt; 0.5 ppm</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Vertical Sash Design Height</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Horizontal Sash Max (Left, Center, Right)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vertical Sash Design Height</td>
<td>Peak &lt; 0.5 ppm Max 45 sec rolling ave. &lt; 0.1 ppm</td>
<td>Peak &lt; 0.5 ppm Max 45 sec rolling ave. &lt; 0.1 ppm</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Horizontal Sash Max (Left, Center, Right)</td>
<td>Peak &lt; 0.5 ppm Max 30 sec rolling ave. &lt; 0.1 ppm</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Vertical Sash Design Height</td>
<td>Indicated velocity or flow ± 10% variation from corresponding measured value</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Horizontal Sash Max (Left, Center, Right)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
1. Room temperature shall be 72°F ± 2°F
2. Manufacturer shall use equipment specified in Part 2 – Products.
3. Perform additional As Manufactured (AM) tests at 6.0 and 8.0 Lpm and provide results.
4. Perform additional As Manufactured (AM) test to failure by decreasing face velocity with 4.0 Lpm concentration. Report velocity at failure.
FACILITY FALL PROTECTION

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1  GENERAL

1.1 SUMMARY

A. Section includes
   1. Fall protection systems

B. Related sections
   1. Section 05 00 00 “Structural Steel”
   2. Section 07 30 00 “Roofing”
   3. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Coordinate and specify a complete IBC- and OSHA-compliant fall protection system.
   1. WU prefers passive fall restraint systems utilizing an adequately sized parapet. Where parapets or railings are infeasible, specify an active fall arrest system.
   2. Maintain a 4’ minimum clear walk path between all rooftop mounted equipment, photovoltaic panels, and similar items.
   3. Design fall protection systems to eliminate visible warning lines 15’ from the leading edge.
   4. Specify stainless steel materials for posts and other components of exterior fall protection systems.
   5. Review fall protection system with WU PM, WU EH&S, and WU Zone Manager at key project milestones.

B. Engage a preferred fall protection consultant identified in Part 2.

C. Coordination & detailing requirements
   1. Structural Engineer’s responsibilities include, but are not limited to, coordinating plan locations and associated details to resist the loads imposed by the fall protection system.
      a. Indicate maximum height of post above top of roof.
      b. Specify 4” diameter OD post, minimum.
      c. Specify connection from post to supporting structure to be a 5/16” min. fillet weld all around.
      d. At concrete structure, design an oversized embed plate with headed studs and welded rebar to accept fall protection posts.
      e. At concrete on composite metal deck structure, design structural steel shim assembly with oversized top plate welded to steel framing with welded rebar into slab to accept fall protection posts.
      f. At metal roof decks, design oversized connection plates, roof deck connections, and orthogonal framing to accept fall protection posts.
   2. Fall protection consultant’s responsibilities include, but are not limited to, designing a complete fall protection system.
a. Coordinate plan layout, post locations and associated details with the design team.
b. Design system for simultaneous use by two personnel.
c. Specify U-bar, post, and connection to structural system.
d. Specify necessary corrosion resistant signage, including but not limited to maximum number of allowable users, manufacturer’s name, installers name and project number, equipment serial number, installation date, and other required information.
e. Specify cable shuttles with bypass feature.
f. Specify complete equipment for two personnel, including self-retracting lifelines, shock absorbing lanyards, cable shuttles, and harnesses.

3. Other Design Team responsibilities include, but are not limited to:
   a. Locate rooftop equipment and roof access to minimize use of fall protection system.

PART 2 PROVIDERS & PRODUCTS

2.1 PREFERRED FALL PROTECTION CONSULTANTS

   A. Reichle Associates
      610-793-0137
      www.reichleassoc.com
   B. Oates Associates
      314-588-8381
      www.oatesassociates.com

2.2 PRODUCTS

   A. Basis of design
      1. Utilize DBI/SALA 3M “Evolution” as the basis of design fall protection system.

PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS

   A. Include the following text in the appropriate section of the project specifications:
      1. Contractor shall ensure a manufacturer certified installer performs or oversees all installation and certification of fall protection systems.
      2. Contractor shall test 100% of mechanical and adhesive anchors by the manufacturer’s personnel in accordance with manufacturer’s written instructions and deliver a written record of test results.
      3. Contractor shall provide an owner training session for maintenance personnel by a “Competent Person” in the proper use, care, and maintenance of fall protection installations and equipment.
      4. Contractor shall provide a “Certification for Use” form included with O&M Manual.
The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY
   A. Section includes
      1. Manual and motor-operated roller shades with single and double rollers
      2. Horizontal louver blinds with aluminum slats
   B. Related sections
      1. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS
   A. Roller shades
      1. New building construction & major renovations
         a. Specify motor-operated single- and double-roller shades with full integration with WU BAS and adjacent A/V equipment, and local override switches.
         b. Develop an early bid package to allow selection of shade manufacturer and product. Engage the shade manufacturer as a design-assist partner throughout the project for electrical, data, carpentry, and other design requirements.
      2. Minor renovations
         a. WU accepts manually operated shades and motor operated shades without BAS integration.
      3. Shade bands
         a. Review light blocking requirements with WU PM and specify appropriate light sealing.
         b. Review all fabric materials with WU PM prior to shop drawing approval.
   B. horizontal louver blinds
      1. Specify aluminum alloy with crowned profile, radiused corners, 1” x 0.008” min.

1.3 WARRANTY, START UP, COMMISSIONING, & MAINTENANCE REQUIREMENTS
   A. Owner training
      1. Specify owner training by a factory-authorized service representative at project completion.
ELEVATORS

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Summary
   1. Hydraulic passenger elevators, hydraulic service elevators, and electric traction passenger elevators.

B. Related sections
   1. Section 03 30 00 “Concrete”
   2. Section 05 00 00 “Structural and Other Steel”
   3. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Elevator consultant & procurement
   1. Engage the elevator consultant listed in Part 2.
   2. WU prefers to pre-purchase the elevator early in the design process to enable coordination with the specific details and requirements of each manufacturer. Discuss with the WU PM at the beginning of the project.

B. Design requirements
   1. Type
      a. WU utilizes hydraulic elevators for maximum travel distances of 5 stories or 50 feet.
         1) Present heavy duty Machine Room-Less (MRL) elevators as an option, subject to WU’s written approval.
         2) If WU accepts heavy duty MRL elevators, specify all other applicable standards subject to modification for specific differences inherent with MRLs.
      b. WU requires traction elevators for travel distance over 5 stories or 50’.
   2. Rated speed
      a. Review recommended speeds with WU PM. WU utilizes the following elevator speeds in other buildings on campus:
         1) Hydraulic: 100 to 150 fpm
         2) Traction: 200 fpm or faster
   3. Car enclosure, hoistway entrances, and hall fixtures
      a. Size the elevator cab to accept a full stretcher in the horizontal position, minimum.
      b. Specify satin stainless steel or 5WL textured stainless steel cab elements where applicable.
      c. Specify stainless steel doors fabricated by laminating stainless steel sheet to exposed faces and edges of enameled cold-rolled steel doors.
      d. Specify nickel-silver door sills.
      e. Specify metallic finish, plastic laminate ceiling with LED downlights.
      f. Specify manufacturer’s standard, satin stainless steel handrails.

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REVISED 2021

ELEVATORS
14 20 00 - 1
g. Specify protection pads and other associated requirements for all elevators capable of functioning as service elevators.

h. Review all material selections with the Campus Architect and WU PM.

4. Systems and components
   a. Specify a capped PVC liner as the cylinder assembly casing.
   b. Specify welded construction for car frames and platforms.

5. Signal equipment
   a. Specify vandal resistant equipment.
   b. Specify a hands free emergency two-way communication system in the elevator cab capable of communicating with WU Police Department (314-935-5555).

6. Operation systems
   a. Specify a universal controller system per Part 2 with the following functionality:
      1) On-board self-diagnostics
      2) Communication with the centralized WU monitoring system over campus telephone lines
      3) Communication with a remote expert to create diagnose elevator issues and return the elevator to service
      4) Real-time status updates via text or email
      5) Remote alteration of elevator functions
   b. Specify provisions for fire fighters’ service operation, independent service, and automatic return to a level designated by the Fire Marshal.
   c. Coordinate key switches and card access with WU PM and Access Control & Electronic Security Office. WU utilizes “FEOK1” fire department keys.

7. Elevator machine rooms
   a. Locate the elevator machine room at the first landing as close to the elevator shaft as possible.
   b. Size the room for all equipment and clearances without the use of a mezzanine.
   c. Specify a 3'-6” minimum door to accommodate equipment installation.
   d. Isolate the room from surrounding areas with fire-rated, sound-rated, and vibration reducing assemblies as required.
   e. Ensure the room contains only elevator machinery and equipment.
   f. Design HVAC system to maintain room conditions between 65° and 90°F, unless the elevator manufacturer requires a tighter bandwidth.
   g. Specify all piping above grade.
   h. Specify a dedicated, duplex GFCI convenience outlet.

C. Miscellaneous
   1. Design an elevator vestibule enclosing the elevator door at all exterior, exposed conditions.
   2. WU accepts gypsum board shaft-wall hoistways for retrofit projects.
   3. WU prefers elevator guiderails capable of spanning floor to floor without the use of backup steel. Where floor-to-floor distances exceed guiderail capacities, design supplemental framing to provide support for guiderail intermediate brackets.
   4. Elevator pit
      a. Coordinate waterproofing and concrete admixture requirements.
      b. Specify an oil miser type pump with sensor to detect oil, shutoff, and alarm to BAS and provisions for discharging effluent from the sump.
      c. Specify a dedicated, GFCI duplex convenience outlet and LED light fixture with switch adjacent to the pit ladder.
   5. Verify the design provides adequate overhead clearance (refuge space) between top of elevator cab and structure above when elevator is at top floor. Where the elevator requires a hoist beam, verify the refuge space from the bottom of the beam.
6. Verify the current requirements for heat and smoke detectors, sprinklers, and shunt-trip breakers with the Fire Marshal and AHJs.

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

A. Submittal requirements
   1. If pre-purchase does not occur, specify a two-part submittal review process to expedite information needed for the “early work,” such as plunger-cylinder assembly, pit dimensions, shaft dimensions, sleeves, inserts, shaft guide rails, machine room equipment, and any other work impacting structure. The Project Team may review and submit the balance of the submittals that will not affect the work of other trades at a later date (e.g., cab interiors, etc.).
   2. Specify complete wiring diagrams detailing circuits for power, signal, and control systems which clearly indicate elevator manufacturer-installed wiring, field-installed wiring, and wiring not included in this Section, including points of connection to work provided by others.

B. Regulatory requirements
   1. UL and FM Global
   2. Authorities Having Jurisdiction
      a. State of Missouri
      b. St. Louis County, City of St Louis, City of University City, or City of Clayton

C. Specify a pre-installation meeting.

1.4 WARRANTY, START UP, COMMISSIONING, & MAINTENANCE REQUIREMENTS

A. Specify a one year Special Warranty period.

B. WU maintains a separate service agreement for elevator maintenance across the entire campus. Do not specify the submission of a continuing maintenance proposal.

C. Specify an Owner training session including the following topics:
   1. Proper use and operation
   2. Emergency procedures
   3. Access to components
   4. Owner-required maintenance not provided by maintenance agreement
   5. Diagnostic functions
   6. Points of interconnection for required communication systems
   7. Life safety features
PART 2 PROVIDERS & PRODUCTS

2.1 PREFERRED ELEVATOR CONSULTANT

A. K. H. Lemp Elevator Consultants
   636-861-2722
   www.khlempp.com

2.2 MANUFACTURERS

A. Specify elevators based on WU’s acceptance criteria:

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Hydraulic</th>
<th>Electric Traction &amp; Heavy Duty MRL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced</td>
<td>Acceptable</td>
<td>--</td>
</tr>
<tr>
<td>Kone</td>
<td>Acceptable</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Midwest</td>
<td>Acceptable</td>
<td>--</td>
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<tr>
<td>Otis</td>
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<td>Acceptable</td>
</tr>
<tr>
<td>Schindler</td>
<td>--</td>
<td>Acceptable</td>
</tr>
<tr>
<td>ThyssenKrupp</td>
<td>Acceptable</td>
<td>Acceptable</td>
</tr>
</tbody>
</table>

B. Specify a universal controller as follows:
   1. Specify Motion Control Engineering 2000 as the basis of design.
   2. WU accepts similar systems by Elevator Controls Corporation and GAL Manufacturing.

PART 3 EXECUTION – NOT USED
21 00 00

FIRE SUPPRESSION

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
1. Fire department connections
2. Fire suppression standpipes
3. Fire suppression sprinkler system
4. Clean agent fire extinguishing system
5. Fire pumps

B. Related sections
1. Section 22 05 00 & 23 05 00 “Common Work Results for Plumbing & HVAC”
2. Section 22 05 53 & 23 05 53 “Identification for Plumbing & HVAC”
3. Section 33 00 00 “Campus Utility Services”
4. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. General
1. WU obtains insurance through FM Global.
2. WU utilizes Johnson Controls (formerly Tyco SimplexGrinnell) fire alarm systems.
3. Specify a base bid sprinkler system conforming to NFPA-13 and NFPA-14 with the following modifications:
   a. All products and equipment shall be FM Global listed.
   b. Hazard and water flow density shall be per FM Global Data Sheets.
   c. Seismic bracing shall be per FM Global Data Sheets.
4. Specify an alternate bid sprinkler system fully designed to FM Global Data Sheets and certified/sealed by the fire protection engineer for permitting purposes as NFPA compliant.
5. Specify a fully sprinklered system for new buildings and gut rehabs of existing buildings.
6. For major renovations of existing buildings that are not fully sprinklered, design a fire service entrance sized for the entire building and specify fully sprinklered for the renovated area. Coordinate with the WU PM for project scope of non-renovated spaces.
7. Coordinate with the WU PM for project scope in the case of minor renovations of existing buildings that are not fully sprinklered.
8. Typical systems
   a. Specify wet pipe systems, including sprinklers and standpipes, unless noted otherwise.
   b. Specify dry pipe systems in parking garages and other special spaces requested by WU.
   c. Specify dry pipe pre-action systems for large computer rooms, animal areas, and other special spaces requested by WU.
d. Specify wet pipe pre-action systems for areas where accidental damage is highly probable (e.g., gymnasiums) and other spaces requested by WU.

9. Do not specify plastic piping.

B. Water flow test
   1. Identify the water tie-in point and request a water flow test from the WU PM. Include the test data in the project documents.

C. Fire department connections (FDC)
   1. Specify building mounted FDC’s. Free standing FDC’s are not acceptable due to thrust considerations.
   2. Locate FDCs based on fire lane access and efficient routing to the sprinkler system. Coordinate location with the project team, including the WU PM who will obtain Fire Marshal approval.
   3. Coordinate the FDC, Knox box, and fire alarm annunciator for a unified emergency response.
   4. Indicate proposed ball drip location and drain piping on the plans.
   5. In finished spaces, coordinate wall thickness or a chase to conceal piping.
   6. Indicate a minimum of (1) 2-1/2” connection per 250 GPM of system demand.
   7. Coordinate with project team and specify the FDC finish.

D. Post indicating valve
   1. Specify post indicating valves only when the project site is within the City of Clayton (i.e. South 40, West Campus, and South Campus). Other locations do not require a post indicating valve.
   2. Specify the building fire alarm system monitors the post indicating valves. Coordinate with Electrical Consultant to show on the drawings an underground conduit rough-in and foundation penetration as required. Locate the conduit adjacent to the water pipe.

E. Standpipes
   1. Typically, specify manual pumped Class I standpipes.
   2. Specify recessed solid door valve cabinets for standpipes located in finished circulation stairwells. Coordinate chase requirements with the project team during the SD phase to ensure adequate stairwell dimensions.
   3. WU accepts either concealed or exposed standpipes in back-of-house egress stairwells. Coordinate with the Architect and WU PM.
   4. Differentiate on the drawings between concealed standpipes with valve cabinets versus exposed standpipes.

F. Fire suppression sprinkler system
   1. Show the following on the construction drawings:
      a. Exterior pipe routing to fire water source with isolation valve at tie-in location
      b. Isolation valve at branch from domestic water, if combined water service
      c. Double check valve backflow preventer
      d. Zone risers and interior pipe main routings
      e. Standpipe routings
      f. Fire department connection
      g. Test/drain piping including point of discharge
      h. Valve cabinets locations
      i. Hazard type of each space
   2. Do not size the piping. Delegate the hydraulic calculations to the contractor.
   3. Indicate on the drawings the number of zones and the location of each zone. At a minimum, indicate each floor as a separate zone.
   4. Sprinkler heads
a. Indicate head layouts for special Architectural spaces.
b. Indicate head layouts for repetitive spaces such as dorm rooms, office suites, etc.
c. Specify sprinkler heads centered in 2’x2’ ceiling tiles.
e. Specify FM Global approved corrosion resistant coatings for areas with greater risk of corrosion, such as high humidity levels or chemical environments.
f. Typical sprinkler head schedule
   1) White acoustical ceilings: Semi-recessed, white finish
   2) Other finished ceilings: Flush concealed type, finish coordinated with ceilings: chrome, brass, black, stainless, factory custom painted, etc.
   3) Finished spaces without ceilings, ceiling white paint: Upright or pendant type, white finish
   4) Unfinished spaces: Upright or pendant type, brass finish
   5) Ancillary spaces subject to freezing: Dry barrel type
   6) Where applicable: Sidewall type

5. Coordinate with Plumbing Consultant to size drains capable of accepting the discharge of test connections, riser drains, backflow preventers, FDC ball drips, etc.
6. Coordinate with Electrical consultant to specify a visual indication device at the FDC location. Do not permit alarm bells or water gongs.
7. Where dry type systems or subsystems are used, coordinate with Electrical Consultant for a circuit for the air compressor.
8. Indicate on the drawings the locations of all tamper switches, supervised valves, and flow switches. Coordinate with the fire alarm drawings.
9. Indicate on the drawings the locations of any water curtains or other special requirements.

G. Dry pipe systems
   1. Specify nitrogen or vacuum type dry pipe systems for corrosion protection.

H. Clean agent fire extinguishing system
   1. Specify a clean agent system for sensitive spaces with electronics or other high value equipment.
   2. Coordinate with project team to program space for an equipment room adjacent to the protected space.
   3. Performance requirements:
      a. Specify the clean agent shown in Part 2.
      b. Specify discharge within 10 seconds and 4.5% concentration by volume at 70°F for 10 minute holding time in hazard areas.
      c. Specify 10.0% maximum concentration in hazard areas immediately after discharge.
      d. Specify 4.2% minimum concentration throughout holding time.
   4. Specify a Simplex releasing panel. Coordinate with fire alarm consultant for detection devices and clean agent system monitoring.
   5. Include HVAC duct and HVAC unit volume in calculations or isolate these systems with control dampers and end switches sequenced with the smoke detection and clean agent release.

I. Fire pumps
   1. Typical buildings on the Danforth Campus and South 40 do not require a fire pump.
   2. WU prefers to increase the sprinkler system pipe size for cost and reliability purposes prior to specifying a fire pump and associated emergency generator system.
   3. Notify WU if the design team believes the project requires a fire pump.
1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

A. Specify a sequential, three component fire sprinkler submittal review process:
   1. Equipment cut sheets and product data.
   2. Layout drawings
      a. Prior to performing hydraulic calculations, sizing pipes, or seeking approvals from the AHJs, submit drawings which include all piping, sprinkler head locations, and pipe elevations.
      b. The project team will review the layout drawings for compatibility the design intent and aesthetic concerns. Specify minimum head spacing per FM Global requirements and additional heads to accommodate the Architect’s reflected ceiling plan.
      c. Contractor shall layout any areas not shown on the plans with symmetry in mind.
   3. Approval drawings
      a. Create submittals containing all information required for approval by AHJ and for field construction. Do not permit contractor to start fabrication or installation until receiving approval from the AHJ and approval from the design team.

B. Require contractor to model seismic braces for BIM clash detection process.

PART 2 PROVIDERS & PRODUCTS

2.1 MANUFACTURERS

A. Specify products from the following manufacturers due to local representation and support. Submit other manufacturers with local representation and support to the WU PM for approval.
   2. Sprinkler heads, FM Global listed: Central, Guardian, Reliance, Star, Viking
   3. Sprinkler head guards, high abuse areas: SprinkGuard
   4. FDCs: American Fire Supply, Elkhart Brass, Guardian, Potter Roemer
   5. Flexible hoses: Flexhead Industries (no substitutions)
   6. Clean agent: 3M Novec 1230 (no substitutions)
   7. Fire pumps: A-C Fire Pump, Aurora, Fairbanks Nijhuis, Peerless Pump

2.2 MATERIALS

A. Specify materials, insulation, valves, and other items per the applicable Schedule.

PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS

A. Include the following text in the appropriate section of the project specifications.
   1. All equipment shall be FM Global and UL listed.
   2. The Contractor shall not seek design or code interpretations directly from the AHJ. The Contractor shall submit design related questions in writing to the Architect/Engineer. The Contractor may pursue procedural questions related to the permitting process. The Contractor shall file and pay the permit cost.
3. Pipe velocities shall not exceed 20 ft/sec in any section of the piping system to provide long term flexibility of water demand changes due to renovations or hazard class changes.

4. Sprinkler heads shall be located on return bends and centered +/- 1” on 2x2 ceiling tiles.

5. Where piping enters/ exits a room without a ceiling from/to a room with a ceiling, offsets/elevation changes shall be located above the ceiling and concealed such that the offsets/elevation changes are not visible in the room without a ceiling.

6. The Contractor shall locate heads in the field from the final wall locations. The Contractor shall notify the Architect where the center of tile location exceeds the maximum distance of the sprinkler. Additional heads shall be provided and the layout modified as directed by the Architect/Engineer at no additional cost to the Owner.

7. Preliminary testing shall be conducted to assure proper operation before the final test is scheduled with the AHJ and shall be observed by WU’s representative. Deficiencies shall be corrected and retested prior to scheduling the final test with the AHJ. Prior to this testing, pipes shall be flushed, hydrostatically tested, and all valves and devices shall be operated. All requirements of “System Acceptance” of NFPA 13 shall be met in full. The sprinkler system shall be final Acceptance tested in the presence of the WU Representative and the governing AHJs for approval.

8. In sprinkler systems that require a fire pump to meet sprinkler requirements, the sprinkler pipe sizes shall be based on Pipe Schedule method to provide maximum sprinkler operation when the fire pump is not available and to minimize the size of the fire pump and emergency generator system.

9. For clean agent systems, the Contractor shall conduct a minimum of two blower door tests for all doors along the perimeter of each fire zone. The Contractor shall provide all required testing equipment. Preliminary testing shall be conducted to assure proper operation before the final test is scheduled with AHJ and shall be observed by WU’s representative. Deficiencies shall be corrected and retested prior to scheduling the final test with the AHJ.
The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Sleeves
   2. Meters
   3. Valves
   4. Gauges
   5. Thermometers
   6. Hangers
   7. Supports
   8. Vibration isolation
   9. Seismic
   10. Pipe cleaning
   11. Equipment cleaning
   12. Drains

B. Related sections
   1. Section 03 00 00 “Concrete”
   2. Section 22 05 53 & 23 05 53 “Identification for Plumbing & HVAC”
   3. Section 22 07 00 & 23 07 00 “Insulation for Plumbing & HVAC”
   4. Section 22 11 00 “Facility Water Distribution”
   5. Section 22 13 00 “Facility Sanitary Sewerage”
   6. Section 22 14 00 “Facility Storm Drainage”
   7. Section 23 20 00 “HVAC Piping and Pumps”
   8. Section 23 50 00 “Central Heating Equipment”
   9. Section 23 60 00 “Central Cooling Equipment”
   10. Section 23 30 00 “HVAC Air Distribution”
   11. Section 33 00 00 “Campus Utility Services”
   12. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN & PERFORMANCE REQUIREMENTS

A. Penetrations and sleeves
   1. Coordinate with structural engineer and indicate on drawings all required sleeves, holes, block outs, etc. Where applicable, identify insulation, firestop, mechanical rubber seal sizes, and overall hole size on construction drawings.
2. Specify a water stop ring and a mechanical rubber seal in accordance with manufacturers’ requirements at holes through foundation walls. For pre-insulated piping, specify mechanical rubber seals sized for jacket outside diameter.

3. Size holes through internal walls for pipe/insulation and firestop, where required, in accordance with manufacturers’ requirements for annular space.

4. Specify sleeves as follows:
   c. Existing non-structural wall: Not required. Specify core drill or neat sawcut. Verify with a structural engineer the wall is non-load bearing.
   d. Existing structural wall: Consult with a structural engineer for structural requirements.
   e. Floors, general dry locations: Not required. Specify a block-out for new construction or reinforcement scan and core drill for existing construction.
   f. Floors, wet locations and mechanical rooms: Specify Sch. 40 galvanized steel pipe, 2” minimum above the finished floor. Specify a concrete curb in areas with multiple penetrations.

B. Meters
1. Specify meters on the building utility usage:
   a. Chilled water and heating water: Onicon F-3500 series insertion magnetic flow meter with System 10 BTU totalizer with auxiliary input card.
   b. Natural gas: Onicon F-5400 series thermal mass flow meters connected to System 10 BTU totalizer, preferably an auxiliary input on another System 10.
   c. Water: Turbine type meter with pulse output connected to Onicon System 10. Specify BAS monitoring of water meters.
   d. Steam: Steam meters are only necessary at boiler plants. Consult with WU PM.
   e. Steam condensate: Niagara model WPX210 high temperature turbine type meter with pulse output connected to Onicon System 10. Detail flow meters horizontally in a loop to ensure they remain wetted. This meter measures direct steam usage and is not typical.

C. Valves, drains, and vents
1. Specify high quality valves, not “Contractor/Value/Economy” models.
2. Specify valves made in the USA.
3. Specify valve model numbers as a basis of design.
4. Specify screwed, sweated, or flanged valves. Press/Plain-end connections are not acceptable.
5. When one service uses two or more valves of the same type, specify and ensure one manufacturer provides all valves of this type.
6. Specify valves 3” and smaller as ball valves.
   a. Specify bronze body, two-piece valves, full port, with stainless steel ball and trim.
   b. Specify metal stem extensions on insulated heating valves.
   c. Specify non-metallic insulated T-handle for cold piping that may sweat.
7. Specify valves 4” and larger as butterfly or resilient seat gate valves.
   a. Specify ductile iron body butterfly valves, threaded lug type, peroxide cured EPDM seat, aluminum bronze disc, 416 SS stem, bronze or Teflon bushings, and stem seals material matching the seat material.
   b. Specify 200 psi rated, bi-directional bubble tight dead-end service with no downstream flange required.
   c. Specify gear operators for butterfly valves larger than 6”.
d. Specify resilient seat gate valves with a ductile iron body, bolted bonnet, non-rising stem, peroxide cured EPDM coated ductile iron wedge, and epoxy coated inside and outside per AWWA C550.

8. Specify chain wheel operators for main isolation valves 6” and larger, located 12’ AFF in mechanical rooms and tunnels.

9. Specify drain valves as two-piece ball valves sized proportional to the volume of the piping requiring drainage. Specify 3/4”, 1-1/2”, or 2-1/2” with valve-size straight hose thread adapters, cap, and chain.

10. Specify manual air vents as a 3/4” two-piece ball valve with 3/4” hose end adapter, cap, and chain.

11. Do not specify balance valves for pumps with VFDs.

12. Do not specify triple duty valves.

D. Pressure gauges

1. Specify pressure gauges at domestic water service entrance, pumps, boilers, chillers, and at equipment to assist with maintenance and trouble shooting.

2. Specify 4-1/2” diameter pressure gauges with 0.5% accuracy.

3. Specify gauge ranges on flow diagrams or schedules. Select ranges from approximately 67% to 75% of maximum operating pressure.
   a. Domestic water: 0-160 psi at water service entrance and 0-100 psi elsewhere
   b. Chilled water: 0-160 psi
   c. Local heating water systems: Design pressure = Relief valve pressure (expanded water pressure at expansion tank) + pump head
   d. Low pressure steam: 0-30 psi

4. Specify porous type snubbers at pump locations or other locations with pressure impulses.

5. Do not specify gauges at AHU coils; specify gauge cocks or P/T ports.

6. Specify gauge cocks as 1/4” ball valves. Specify gauge cocks before any change of direction from the system piping to allow rodding in the event of blockage.

7. For differential pressure across equipment, specify a single gauge with tubing to supply and return with valves at each tubing connection to the piping/equipment.

8. Where equipment/pump has a strainer, specify a single gauge with tubing which includes a third connection to also allow reading differential pressure across the strainer.

E. Thermometers

1. Specify Liquid-in-Glass thermometers for liquid systems as follows:
   a. 9” adjustable type with brass wells
   b. +/- 1 scale division accuracy

2. Specify thermometers at equipment that has a temperature change or requires adjustment to regulate temperature.

3. Specify thermometer ranges based on location and operating temperatures for maximum resolution. Typical temperature ranges:
   a. Domestic hot water: 30-180°F, with 2°F scale divisions
   b. Domestic cold water: 0-100°F, with 1°F scale divisions
   c. Heating hot water: 30-240°F, with 2°F scale divisions
   d. Condenser water: 30-120°F, with 1°F scale divisions
   e. Chilled water: 0-100°F, with 1°F scale divisions
   f. Steam condensate: 30-240°F, with 2°F scale divisions

F. Hangers and supports

1. Indoor, dry locations with steel pipe material: Specify electroplated or other standard protective coating. Bare, uncoated steel is not acceptable.
2. Exterior locations or other areas with increased corrosion risk: Specify hot dipped galvanized, aluminum, or stainless steel supports and hangers. Analyze the entire system for galvanic corrosion and detail all required isolation of mixed metals.

3. “Cold” piping systems: Specify hanger and support size based on the outside diameter of the insulation to maintain a continuous vapor barrier.

4. Copper piping material: Specify copper plated, rubber coated hangers and supports.

5. In new concrete construction, mechanical equipment rooms, corridors, and other locations that are hanger intensive, coordinate with structural engineer to specify threaded inserts placed at a maximum of 4'-0" on center each way to allow planned construction and future renovations to utilize this system for MEP support.

6. Do not utilize or permit existing metal or wood roof decks to support piping, ductwork, or equipment.

7. Where pipe stands are not on a housekeeping pad, specify a 1” minimum grout pad below the baseplate to minimize corrosion.

8. Design for pipe expansion/contraction and indicate roller hangers, saddles, guides, slides, and anchors on the construction drawings.

9. Coordinate with structural engineer to evaluate impact of non-modeled BIM structural elements on MEP/FP routing.

G. Equipment pads
   1. Specify a 4” concrete housekeeping pad for floor mounted equipment.
   2. Specify equipment pads that accommodate required edge distance for anchor bolt seismic forces.
   3. Design reinforcement in accordance with ASHRAE Practical Guide to Seismic Restraint or coordinate with a structural engineer.

H. Vibration isolation
   1. On occasion, Acoustic Consultant recommendations have been overly conservative and resulted in non-typical installations for WU. The acoustic consultant shall review the requirements for vibration isolation of rotating equipment with the mechanical consultant and WU PM at milestone reviews.
   2. WU prefers piping vibration isolation to be two flexible grooved couplings with 12” minimum separation on the equipment side of the service valve. In special cases where additional isolation is required and approved by WU PM, specify stainless steel flexible connectors. Do not specify rubber flexible connectors.

I. Seismic
   1. For renovation projects without a geotech report, review Appendix for seismic site classification.

J. Unions
   1. Do not specify or allow dielectric unions.
   2. Where disassembly is required, detail the appropriate flanges, couplings, or all-bronze unions.
   3. See Figure “Pipe Material Transitions.”

K. Pipe cleaning
   1. Specify cleaning for all new piping and altered, extended, or repaired portions of existing piping.
   2. Indicate the extent of new or modified piping to be pressure tested, flushed, and cleaned using keyed notes on the drawings.
   3. Specify that potable water shall pass laboratory test before use.

L. Drains
1. Specify a 24” diameter block out around roof and floor drains set in concrete to allow final elevation to be determined after primary pour.
2. Specify adjustable type roof drains to allow construction drainage and setting of final drain elevation by roofing contractor.

PART 2 PROVIDERS & PRODUCTS

2.1 MANUFACTURERS
A. Specify products from the following manufacturers based on local representation and support. Submit other manufacturers with local representation and support to the WU PM for approval.
1. Valves: Apollo, Hammond/Milwaukee, Nibco, Watts
2. Pressure gauges: Marsh, Marshalltown, Miljoco, Trerice, Weiss Instruments, Weksler
3. Thermometers: Marsh, Marshalltown, Miljoco, Trerice, Weiss Instruments, Weksler
4. Water meters: Badger, Hersey, Kent, Neptune, Niagara

2.2 MATERIALS
A. Specify materials, insulation, valves, and other items per the applicable Schedule.

PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS
A. Include the following text in the appropriate section of the project specifications:
1. Contractor coordination models shall identify service clearances.
2. Contractor coordination models shall include seismic supports.
3. Contractor shall submit a letter from the Seismic engineer stating that the completed installation meets the design intent.
4. Contractor shall not install dielectric unions.
5. The design intent is to specify high quality HVAC/Plumbing valves, not lower quality “Contractor/Value/Economy” series valves. Contractor shall provide valves “Made in USA.” Contractor shall not provide valves manufactured by third party OEM suppliers. Valve submittal shall indicate where the valve is assembled and tested.
6. Where thermometer wells are installed below 5’, Contractor shall install on the side of vertical piping or on the top of horizontal piping so they may be angled back beyond vertical to allow easy reading. Where thermometer wells are installed above 6’ on vertical piping, Contractor may install on the face or the side. Where thermometer wells are installed above 6’ on horizontal piping, Contractor shall install between 9 and 12 o’clock to allow the thermometers to be angled less than vertical without the pipe blocking the view of the thermometer. Contractor shall install thermometers on the equipment side of vertical piping in lieu of service aisle side of piping.
7. Contractor shall only use those seismic materials submitted and approved. Contractor shall notify Seismic Engineer when actual installation differs from the approved seismic shop drawing.
8. Contractor shall not include prefabricated pipe/support assemblies in base bid price but shall include cost savings as a voluntary alternate. Where prefabricated pipe/support assemblies are allowed by Owner, the details and savings shall be negotiated separately post bid. Contractor shall
ensure there is adequate room for trapeze hangers that may not have been accounted for in the
design. Contractor shall remove longitudinal braces between pipe supports after installation.

9. Contractor shall not include prefabricated equipment skids in base bid price but shall include cost
   savings as a voluntary alternate. Where contractor fabricated skids are allowed by Owner, the
details and savings shall be negotiated separately post bid. Skids shall be hot dipped galvanized or
constructed of non-ferrous materials for long term corrosion resistance. Contractor shall submit skid
shop drawings for approval.

10. Contractor shall not use metal or wood roof decks for supporting the piping, ductwork, or
equipment. Power driven inserts and attachments are not permitted.

11. Contractor shall clearly identify on mechanical shop drawings the areas that cast in place inserts are
   required. Identify a detailed layout on the shop drawings if required.

12. Contractor shall provide all required labor for draining, filling, venting, and testing of new or
    modified systems as many times as required during construction and for all phasing activities. When
    draining and filling systems affects other systems or the Owner’s normal operations, then the work
    shall be scheduled per WU’s General Conditions and carried out to minimize disruptions.

13. Contractor shall provide all flushing media, cleaning chemical, inlet connections, temporary
    circulation pumps, discharge or drainage outlets, and any temporary provisions to protect
    components to facilitate flushing and cleaning. Flush clean and drain all low points in the piping.
    After acceptance remove, clean and replace all strainer screens and filters.

14. Potable water quality acceptance tests shall include tests from the pipe indicated on the drawings
    and a nearby reference sample. Test all samples for the following:
    a. Total coliform
    b. E-coli
    c. pH
    d. Alkalinity
    e. Turbidity

15. Hydronic water quality acceptance tests shall include tests from the pipe indicated on the drawings
    and a nearby reference sample. Test all samples for the following:
    a. pH
    b. Alkalinity
    c. Turbidity
IDENTIFICATION FOR PLUMBING & HVAC

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Equipment labels
   2. Warning signs and labels
   3. Pipe labels
   4. Duct labels
   5. Stencils
   6. Valve tags
   7. Warning tags
   8. Underground warning tape

B. Related sections
   1. Section 21 00 00 “Fire Suppression”
   2. Section 22 11 00 “Facility Water Distribution”
   3. Section 22 13 00 “Facility Sanitary Sewerage”
   4. Section 22 14 00 “Facility Storm Drainage”
   5. Section 23 20 00 “HVAC Piping and Pumps”
   6. Section 23 60 00 “Central Cooling Equipment”
   7. Section 23 65 00 “Cooling Towers”
   8. Section 23 30 00 “HVAC Air Distribution”
   9. Section 25 00 00 “Integrated Automation Facility Controls”
  10. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Equipment identification
   1. Consult with WU PM for Asset Management tag requirements and specify accordingly.
   2. Identify equipment using an alpha numeric name from the table below.
      a. The alpha part is the equipment abbreviation.
      b. The numeric part shall be 3 digits. Note special cases for the first digit.
   3. When adding equipment within an existing building, use the same numbering scheme as the existing building and use the next number in the equipment series. Typically, equipment number XYZ-001 already exists. Coordinate with the WU PM.
   4. Specify appropriately sized nameplates permanently attached to major equipment items (i.e., chillers, air handling units, fans, terminal units, pumps, boilers, etc.)
   5. Specify brass valve tags for valves 1” and larger and for small equipment items (i.e., in-line pumps, pot feeders, etc.).
6. Specify labeling for equipment controlled by the Building Automation System as follows:
   a. 3-1/2” x 5” yellow label with black letters:
      OSHA / ANSI compliant “CAUTION” header
      “THIS EQUIPMENT IS UNDER AUTOMATIC CONTROL AND MAY START/STOP AT ANY TIME.”

B. Nameplates
   1. Specify interior equipment nameplates as follows:
      a. 1/16” thick, two-ply, black, acrylic plastic
      b. 2-1/2” x 1” minimum size for equipment face area less than 16 SF and 4” x 2” minimum size for equipment face area greater than 16 SF
      c. 1/2” tall minimum white characters
      d. Zinc plated steel rivets. Adhesive or screws are not acceptable.
      e. Tag size shall be appropriate for equipment name
   2. Specify exterior equipment nameplates as follows:
      a. 0.032” thick, engraved stainless-steel plates
      b. 4” x 1-1/2” minimum size
      c. 1/2” tall minimum black enamel filled characters
      d. Stainless-steel rivets. Adhesive and screws are not acceptable.

C. Valve tags
   1. Specify valve tags as follows:
      a. 0.032” thick brass stock
      b. 1-1/2” diameter minimum
      c. 1/4” legend and 1/2” valve number per “Identification” section below with black enamel filled characters
      d. #16 brass jack chain
   2. Valve tags on equipment isolation valves are not required (i.e. supply and return valves located closest to equipment where valve’s purpose is obvious)
   3. Specify chain lengths which place the tag below the level of piping to allow quick identification of valves and tags.
   4. Specify valve tags for balance valves only when used as a combination balance/service valve.

D. Pipe labels
   1. Specify pre-printed, color-coded, with lettering indicating service and showing flow direction according to ASME A13.1, latest version.
   2. Specify pipe label materials as follows:
      a. Indoor, except mechanical rooms: Self-adhesive vinyl
      b. Mechanical rooms and exterior: Pre-coiled, 0.020” minimum semi-rigid plastic formed to cover full circumference of pipe.
   3. WU does not require pipe painting/color coding.

E. Duct labels
   1. Self-adhesive vinyl indicating service and directional arrows
   2. Specify duct labels as follows:
      a. Supply-, outside-, relief-, return-, and mixed-air ducts: Green background with white letters
      b. Exhaust-air ducts: Yellow background with white letters

F. Stencils
   1. Stencils are not acceptable.

G. Underground warning tape
   1. Specify installation 12” above the piping.
2. Specify continuous 6” wide x 0.004” polyethylene film over metallic pipe.
3. Specify continuous 6” wide x 0.035” metallic detection tape over non-metallic pipe.
4. Specify color and lettering for below grade piping according to the following legend:

<table>
<thead>
<tr>
<th>Service</th>
<th>Color</th>
<th>Legend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sewer</td>
<td>Green</td>
<td>Caution Buried Sewer</td>
</tr>
<tr>
<td>Potable Water</td>
<td>Blue</td>
<td>Caution Buried Water</td>
</tr>
<tr>
<td>Non-potable Fire (S. 40)</td>
<td>Purple</td>
<td>Caution Buried Reclaimed Water</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>Yellow</td>
<td>Caution Buried Gas</td>
</tr>
<tr>
<td>Fuel Oil</td>
<td>Yellow</td>
<td>Caution Buried Fuel</td>
</tr>
<tr>
<td>Steam</td>
<td>Yellow</td>
<td>Caution Buried Utility Line</td>
</tr>
<tr>
<td>Chilled Water</td>
<td>Purple</td>
<td>Caution Buried Reclaimed Water</td>
</tr>
<tr>
<td>Condenser Water</td>
<td>Purple</td>
<td>Caution Buried Reclaimed Water</td>
</tr>
<tr>
<td>Heating Water</td>
<td>Purple</td>
<td>Caution Buried Reclaimed Water</td>
</tr>
<tr>
<td>Condensate</td>
<td>Purple</td>
<td>Caution Buried Reclaimed Water</td>
</tr>
<tr>
<td>Irrigation Water</td>
<td>Purple</td>
<td>Caution Buried Reclaimed Water</td>
</tr>
</tbody>
</table>

H. Specify naming according to the following legend:

<table>
<thead>
<tr>
<th>Plumbing Equipment</th>
<th>Drawing ID</th>
<th>BAS ID (if different)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic water heater</td>
<td>DWH-xxx</td>
<td></td>
</tr>
<tr>
<td>Domestic hot water pump</td>
<td>DHWP-xxx</td>
<td></td>
</tr>
<tr>
<td>Sump pump</td>
<td>SP-xxx</td>
<td>SUMP-xxx</td>
</tr>
<tr>
<td>Sewage ejector</td>
<td>SE-xxx</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plumbing Piping</th>
<th>Drawing ID</th>
<th>BAS ID (if different)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid waste</td>
<td>AW</td>
<td></td>
</tr>
<tr>
<td>Acid vent</td>
<td>AV</td>
<td></td>
</tr>
<tr>
<td>Domestic cold water</td>
<td>CW (line with single dash)</td>
<td></td>
</tr>
<tr>
<td>Domestic hot water</td>
<td>HW (line with double dash)</td>
<td></td>
</tr>
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<td>Domestic hot water return</td>
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<td>Unit heater</td>
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<td>Vacuum pump</td>
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### Mechanical Equipment, cont.

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<td>(x = AHU number, yy = box number with multiple AHU per building)</td>
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<td>VAV-xyy</td>
<td>(x = floor, yy = unit) with single unit for entire building</td>
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### Mechanical Piping

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<tr>
<td>VAC</td>
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PART 2 PROVIDERS & PRODUCTS

2.1 MANUFACTURERS

A. Specify products from the following manufacturers based on local representation and support. Submit other manufacturers with local representation and support to the WU PM for approval.
   1. Labels and nameplates: Seton, Brady Worldwide Inc, Craftmark, Brimar Industries

PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS

A. Include the following text in the appropriate section of the project specifications:
   1. Contractor shall submit an “Equipment Label Schedule” listing all equipment to be labeled with the proposed content for each label.
   2. Contractor shall submit a “Valve Tag Schedule” listing all systems to be labeled with the proposed content for each tag.
   3. Contractor shall install pipe and duct labels where piping and ductwork is exposed or above accessible ceilings in finished spaces, machine rooms, accessible maintenance spaces such as shafts, tunnels, and plenums, and exterior exposed locations as follows:
      a. Near each valve and control device
      b. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe/duct at branch.
      c. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
      d. At access doors, manholes, and similar access points that permit view of concealed piping/ductwork.
      e. Near major equipment items and other points of origination and termination
      f. Spaced at maximum intervals of 50’ along each run. Reduce intervals in areas of congested piping and equipment.
   4. Contractor shall provide directional flow arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
   5. Contractor shall hang valve tags located above lay-in ceilings such that the valve tag hangs below the level of the piping so valves and tags are easily located.
INSULATION FOR PLUMBING & HVAC

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Plumbing
      a. Domestic cold water piping
      b. Domestic hot water piping
      c. Domestic recirculating hot water piping
      d. Sanitary waste piping exposed to freezing conditions
      e. Sanitary waste piping receiving condensate from cooling
      f. Storm water piping exposed to freezing conditions
      g. Roof drains and rainwater leaders
      h. Supplies and drains for handicap-accessible lavatories and sinks
      i. Domestic water heat exchangers
      j. Domestic water storage tanks
   2. HVAC
      a. Chilled water piping and equipment
      b. Cooling condensate piping
      c. Heating water piping and equipment
      d. Steam and steam condensate piping
      e. Ductwork and plenums

B. Related sections
   1. Section 22 05 00 & 23 05 00 “Common Work Results for Plumbing & HVAC”
   2. Section 22 11 00 “Facility Water Piping”
   3. Section 22 13 00 “Facility Sanitary Sewerage”
   4. Section 22 14 00 “Facility Storm Drainage”
   5. Section 22 30 00 “Plumbing Equipment”
   6. Section 23 20 00 “HVAC Piping and Pumps”
   7. Section 23 30 00 “HVAC Air Distribution”
   8. Section 23 60 00 “Central Cooling Equipment”
   9. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Insulation
   1. Specify insulation thickness to meet ASHRAE 90.1 minimum or better where economically justified.
   2. Specify insulation to be continuous through walls, partitions, and floors.
   3. Specify insulation at domestic cold, hot, and recirculation piping, including piping in wet walls.
4. Specify continuous insulation and a continuous vapor barrier over piping, piping specialties, and equipment that is “cold” (which has the potential to sweat). Identify and specify additional insulation thickness for spaces with a higher dew point due to humidification, water evaporation in space, or other processes.

5. Specify continuous insulation and a continuous vapor barrier over piping and piping specialties in finished spaces with exposed piping, equal to the requirements for “cold” piping.

6. Specify insulation at roof drains to prevent sweating and for noise reduction. Specify insulation on all horizontal storm piping from the roof level to the building main or sub-main that receives continuous flow.

7. Specify insulation at above grade floor drains which receive condensate from cooling coils. Specify continuous insulation from the floor drain to a point where the branch connects to the main or sub-main that receives continuous flow.

8. Specify pipe shields or rigid insulation inserts at support points. Wood blocking is not acceptable.

9. Specify low VOC adhesives, mastics, and coatings.

10. Specify molded fittings of the same material for piping systems with rigid insulation.

11. Specify preformed insulation kits at exposed lavatory or sink piping at ADA accessible locations.

12. Specify rigid insulation for horizontal piping less than 3’ AFF.

B. Metal jackets

1. Specify metal jackets for piping subject to damage or weather. Review locations with WU PM.

2. Indicate on the drawing sections that are to receive metal jacket.
   a. Specify embossed aluminum jacket for weather protection in low abuse applications.
   b. Specify stainless steel jacket for high abuse applications on field insulated equipment.
   c. Specify stainless steel jacket for piping less than 6’ AFF for the following:
      1) Tanks
      2) Heat exchangers
      3) Vertical exposed piping in storage rooms, janitor closets, and high traffic areas in mechanical rooms or aisles less than 3’ wide.

PART 2 PROVIDERS & PRODUCTS

2.1 MATERIALS

A. Specify materials, insulation, valves, and other items per the applicable Schedule.

PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS

A. Include the following text in the appropriate section of the project specifications
   1. Contractor shall reinsulate existing piping to match type, thickness, and jacket of existing at tie-in points to existing system where insulation was removed.
   2. Contractor shall repair or replace damaged insulation as required through project substantial completion and punch list work.
   3. Contractor shall insulate domestic cold, hot, and recirculation piping, including piping in wet walls.
   4. Contractor shall install molded fittings of the same material for piping systems that use rigid insulation. Contractor shall not install PVC fitting covers with fiberglass blankets.
5. Contractor shall install continuous insulation and a continuous vapor barrier over piping, piping specialties, and equipment that is “cold” (which has the potential to sweat). Additionally, the contractor shall perform the following to minimize moisture migration:
   a. Seal the insulation to the process surface with vapor barrier mastic for a cut-off seal to limit moisture migration at a maximum of 40’ intervals on the piping, adjacent to equipment, strainers, control valves, and other devices in the piping.
   b. Seal the primary insulation around protrusions, such as thermometers, gauges, etc., with vapor barrier mastic. Insulate the protrusions to prevent sweating and make vapor tight.
   c. Install removable covers at strainers and pump suction diffusers.

6. Contractor shall stop insulation at nameplates to allow inspection. Seal the ends of insulation and continue the jacket material. Inspection ports shall be constructed as follows based on pipe temperature:
   a. 61°F – 139°F: No insulation, unless noted otherwise
   b. 60°F and below: Removable cover matching system insulation thickness. Seal ends of removable cover, maintain vapor barrier, and install a printed adhesive label “Name Plate.”
   c. 140°F and above: Removable cover matching system insulation thickness. Seal ends of removable cover and install printed adhesive label “Name Plate.”
PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Building water piping
   2. Backflow preventers
   3. Vacuum breakers
   4. Water meters
   5. Water pressure-reducing valves
   6. Temperature-actuated, water mixing valves
   7. Domestic water circulation pumps
   8. Thermostatic recirculation valve
   9. Hose bibbs
   10. Wall hydrants
   11. Roof hydrants
   12. Outlet boxes
   13. Water hammer arresters
   14. Trap-seal primer
   15. Storage tanks
   16. Booster pumps

B. Related sections
   1. Section 22 05 00 & 23 05 00 “Common Work Results for Plumbing & HVAC”
   2. Section 22 07 00 & 23 07 00 “Insulation for Plumbing and HVAC”
   3. Section 33 00 00 “Campus Utility Services”
   4. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Water service entrances
   1. Locate water service entrance piping to avoid high finish areas, stairs, retaining walls, and other locations where excavation and site restoration is difficult and more expensive.
   2. Specify a 2-1/2” emergency water hookup on building exterior connected to the building water service.

B. Backflow preventers
   1. Do not specify backflow preventers for incoming service for Danforth campus and South 40 buildings.
   2. Specify backflow preventers per the plumbing code for cross connections with non-potable systems such as irrigation, HVAC makeup, etc.
3. Specify a reduced pressure backflow preventer for laboratory buildings to protect the dedicated non-potable system.
4. Specify a floor drain with adequate drain capacity and/or an above grade pit to receive the volume of water at locations of reduced pressure backflow preventers.

C. Specify a building main water meter and sub-meters for irrigation, cooling tower makeup, and HVAC makeup. Specify BAS points to monitor the meters.

D. Design risers to occur at permanent structural elements within buildings, such as exterior walls, columns, or chases at elevators or stairs, to prevent relocation during subsequent renovations.

E. Specify a generous quantity of service valves to allow maintenance without impacting large areas of the building. Specify valves for each floor, major branches, bathroom groups, etc.

F. Wall and roof hydrants
   1. Specify non-freeze wall hydrants at approximately 100’ intervals along the building perimeter and at locations requiring water or wash down. Coordinate with the architect to provide sufficient wall cavity space for the building side of the hydrant and piping drop.
   2. WU does not require wall hydrants in restrooms for maintenance.
   3. Specify a non-freeze roof hydrant at roof mounted HVAC equipment, solar panels, and other locations requiring water for maintenance.
      a. In lieu of roof hydrants, specify a 24” tall roof curb open to the building plenum with 4” insulated sheet metal cap and walls. Detail a non-freeze wall hydrant in the sidewall of the curb, wall hydrant bracing, and piping internal to the curb.
   4. Specify corresponding internal service valves to allow for servicing wall and roof hydrants.

G. Hot water storage tanks
   1. Maintain water temperature above 140°F.
   2. Specify mixing valves to reduce temperature.
   3. Locate tanks to allow for working clearances and for eventual replacement without impacting other systems or building elements.
   4. WU prefers multiple smaller tanks in lieu of a single large (500+ gallon) tank.
   5. Specify a floor drain near hot water storage tanks to allowing draining and service.

H. When mixing valves are required, WU prefers electronic central mixing valves over mixing valves at restroom groups or individual fixtures to minimize maintenance. In residential buildings or other occupancies where domestic hot water is critical, specify high/low or 50% parallel mixing valves to provide redundancy.

I. Domestic hot water recirculation systems
   1. Maintain water temperature above 120°F.
   2. Locate the recirculation branch takeoff in the wet wall to provide hot water to low flow fixtures. Control of the return flow shall be with a thermostatic return valve, with high temperature sanitation flush bypass, accessible above the ceiling. Calculate return flow through each branch to offset thermal loss. Size circulation pumps for the sum of all branches. Specify pump controls per ASHRAE 90.1 for energy conservation.

J. Locate air hammer arrestors above an accessible ceiling or behind a wall access panel to allow replacement.

K. Booster pumps are typically not required for the potable water system with the available water pressure and the typical height of buildings. Consult with the WU PM before specifying a booster pump for the
When a process or other application requires a booster pump, specify two parallel pumps at 50% each or N+1 to allow pump maintenance.

PART 2 PROVIDERS & PRODUCTS

2.1 MANUFACTURERS

A. Specify products from the following manufacturers based on local representation and support. Submit other manufacturers with local representation and support to the WU PM for approval.
   1. Backflow preventers: Apollo, Watts, Zurn-Wilkins
   2. Water meters: Badger, Hersey, Kent, Neptune, Niagara
   3. Water pressure reducing valves: Apollo, Watts, Zurn
   4. Temperature actuated, water mixing valves: Acorn, Armstrong, Lawler, Leonard
   5. Domestic water circulation pumps: Armstrong, Bell & Gossett, Grundfos, Taco
   6. Thermostatic recirculation valve: Caleffi ThermoSetter
   7. Hose bibbs & wall hydrants: J.R. Smith, MIFAB, Wade, Watts, Woodford, Zurn
   8. Outlet boxes: Acorn, Guy Gray, IPS Corporation, MIFAB, Oatey
   9. Water hammer arresters: J.R. Smith, Josam, MIFAB, Precision Plumbing Products, Zurn
  10. Trap seal primer: Josam, J.R. Smith, MIFAB, Precision Plumbing Products, Watts.
  11. Storage tanks: A.O. Smith, Bock, Lochinvar, PVI, RBI, Rheem/Ruud
  12. Booster pumps: Armstrong, Bell & Gossett, Grundfos

2.2 MATERIALS

A. Specify materials, insulation, valves, and other items per the applicable Schedule.

PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS

A. Include the following text in the appropriate section of the project specifications:
   1. Contractor shall verify existing systems for sizes, capacity, materials, and elevations before installing new work which ties into existing systems. Contractor shall notify Architect/Engineer upon discovery of any discrepancy. Contractor shall correct work performed prior to verification at no cost to Owner.
The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1  GENERAL

1.1 SUMMARY

A. Section includes
   1. Building sanitary waste and vent piping

B. Related sections
   1. Section 03 00 00 “Concrete”
   2. Section 22 05 00 “Common Work Results for Plumbing & HVAC”
   3. Section 22 07 00 “Insulation for Plumbing & HVAC”
   4. Section 33 00 00 “Campus Utility Services”
   5. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Programming
   1. Avoid pumping lower level sanitary. Present a unified solution from the architect, plumbing consultant, and civil consultant to WU that does not require pumping.
   2. Design system to allow risers to occur at permanent structural elements within buildings, such as exterior walls, columns, or chases at elevators or stairs, to prevent relocation during subsequent renovations.
   3. Locate building sanitary exit points to avoid high finish areas, stairs, retaining walls, and other locations where excavation and site restoration is difficult and more expensive.
   4. When the project consists of a full or partial building renovation, evaluate the condition of the existing sanitary waste and vent piping with the WU PM to develop a replacement scope. Older buildings may have combined sanitary and storm piping that requires separation as part of the renovation.
   5. Prior to issuing Schematic Design documents, the plumbing consultant shall provide the project team with feedback regarding the need for a Type II hood or grease interceptor, including physical location, coordination with internal piping and external site sewers, and consideration for access and maintenance.

B. System design
   1. Separate sanitary and storm piping within the building.
   2. Design separate sanitary discharges for the above grade floors and below grade floors. Maintain a relatively shallow depth to the manhole connection point for the above grade floors.
   3. Specify a backwater valve located in the sanitary manhole at the point of connection for the lower level sanitary waste. Coordinate with civil engineer.
   4. Review trap primer requirements with the AHJ to avoid change orders.
C. Floor drains and cleanouts
   1. Specify deep seal P-traps for all floor drains.
   2. Specify round tops for floor drains in spaces with exposed concrete.
   3. Specify square tops for floor drains and cleanouts in spaces with tile flooring.
   4. Specify square framed cover type cleanouts in tiled walls.
   5. Specify vandal proof fasteners for floor drains in public spaces.
   6. Specify loose cast iron tops for floor drains in mechanical rooms.
   7. Detail and specify floor drains in a second pour per Section 03 00 00 “Concrete.”
   8. Indicate floor and wall cleanouts in plan, section, and isometric details.
   9. Do not specify or allow cleanouts in electrical rooms and telecom rooms.

D. Specify access panels with square type frames in tiled walls. Coordinate finish with architect. Where multiple finishes are required, clearly indicate on the documents which rooms receive which finish.

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

A. Pre-installation meetings
   1. Discuss “Design/Performance Requirements” above with contractors to ensure that field changes do not change WU requirements.

PART 2 PROVIDERS & PRODUCTS

2.1 MANUFACTURERS

A. Specify products from the following manufacturers based on local representation and support. Submit other manufacturers with local representation and support to the WU PM for approval.
   1. Cast iron pipe and fittings: AB&I Foundry, Charlotte Pipe and Foundry, Tyler Pipe
   2. No hub couplings: Anaco/Husky, Ideal Clamps, Tyler Pipe, Mission Rubber Company, Thermafit Industries POC
   3. Drainage Products: J.R. Smith, MIFAB, Wade, Zurn

2.2 MATERIALS

A. Specify materials, insulation, valves, and other items per the applicable Schedule.

PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS

A. Include the following text in the appropriate section of the project specifications:
   1. Contractor shall verify the existing system for sizes, direction of flow, materials, and elevations before installing new work which ties into existing systems. Contractor shall notify Architect/Engineer upon discovery of any discrepancy. Contractor shall correct work performed prior to verification at no cost to Owner. Contractor shall verify existing underground piping via camera, sonde locate, or ground penetrating radar prior to excavation.
2. Contractor shall provide cleanouts as shown on the plans and additional cleanouts as required by code. Contractor shall include cleanout locations on shop drawings.

3. Cast iron pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute® and listed by NSF® International.

4. Cast iron no hub couplings shall be “Standard Duty” ASTM C 1277 and CISPI 310.

5. PVC piping, where allowed, shall be schedule 40 DWV Solid Core. Pipe and fittings shall be manufactured from PVC compound with a cell class of 12454 per ASTM D1784 and conform with National Sanitation Foundation (NSF) standard 14. Pipe shall be iron pipe size (IPS) conforming to ASTM D 1785 and ASTM D 2665. Injection molded fittings shall conform to ASTM D 2665. Fabricated fittings shall conform to ASTM F 1866.

6. Contractor shall install buried PVC pipe in accordance with ASTM F 1668.
The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Building storm piping
   2. Roof and overflow drains
   3. Downspout shoes
   4. Subsoil drain piping
   5. Sump pits and pumps

B. Related sections
   1. Section 07 10 00 “Waterproofing”
   2. Section 22 05 00 & 23 05 00 “Common Work Results for Plumbing & HVAC”
   3. Section 22 05 53 & 23 05 23 “Identification for Piping and Equipment – Plumbing & HVAC”
   4. Section 22 07 00 & 23 07 00 “Insulation for Plumbing & HVAC Piping”
   5. Section 33 00 00 “Campus Utility Services”
   6. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Programming
   1. Avoid pumping storm water. Design system so storm piping discharges shallow with respect to grade and separate from any subsoil drainage systems.
   2. Design system to allow risers to occur at permanent structural elements within buildings, such as exterior walls, columns, or chases at elevators or stairs to prevent relocation during subsequent renovations.
   3. Locate building storm piping exit points to avoid high finish area, stairs, retaining walls, and other locations where excavation and site restoration is difficult and more expensive.
   4. When the project consists of a full or partial building renovation, evaluate the condition of the existing storm piping system with the Owner to develop a replacement scope. Older buildings may have combined sanitary and storm piping that requires separation as part of the renovation.

B. System design
   1. Separate sanitary and storm within the building.
   2. St. Louis County AHJ requires a rainfall value of 6” per hour. Use this value for all portions of the campus regardless of jurisdiction.

C. Roof drains
   1. Design roof sump, roofing material, roof drain, and overflow roof drain such that water freely flows into drains and does not dam up at roofing seams.
2. Specify roof and overflow drains with an adjustable height collar.
3. Specify overflow roof drains with a 2” perimeter dam and locate outside of the sump of the primary roof drain.
4. Coordinate the roofing detail with the Architect and refer to the detail on the plumbing drawings.
5. Indicate overflow drain discharge in a conspicuous location but away from building doors or other locations where water management is problematic. Specify splash blocks in non-paved areas.
6. Specify a downspout nozzle at overflow termination.

D. Downspout boot
1. Specify a cast iron downspout boot with integral cleanout to prevent damage at grade.
2. Alternatively, specify a cast iron downspout boot with a buried wye-connection with a flush cleanout adjacent to the downspout.

E. Subsoil drainage
1. Include details on the construction drawings and specify subsoil drainage piping, envelope of surrounding rock, and geotextile fabric in Division 22. Coordinate with the Architect.
2. The waterproofing system requirements may impact the subsoil drainage system. Coordinate piping inverts, foundation over excavation, footing forming, and other requirements of the subsoil drainage and waterproofing systems with project team during the Design Development phase.
3. Specify solid pipe from the perimeter system to the sump pit to prevent water from migrating under the slab.
4. Specify independent under slab drainage and perimeter systems up to the sump pit.
5. Design a separate local system for elevator pits and other sub-basement conditions.
6. Detail subsoil drain changes in direction with 45’s in lieu of 90’s.
7. Detail all cleanouts on drawings after 135 degrees of change in direction and at intervals less than 100’. Coordinate with Architect for cleanout locations.
8. Specify a cast iron top for cleanouts at grade. In planting beds, specify a 12”x12”x4” concrete pad surrounding the cast-iron top.

F. Sump pits and pumps
1. Typically, the subsoil drainage system flows to an indoor duplex sump pump which discharges to the storm line at the basement ceiling or leave separately at the basement ceiling.
2. Specify double seal type sumps for additional water protection.
3. Specify a rail guide system to allow pump repair without disturbing piping.
4. Indicate for the service valve and check valve be located above the cover.
5. Indicated the discharge piping and wiring go through the cover in lieu of underground.
6. Specify BAS general alarm monitoring points for pumps.
7. If the building has a generator, connect sump pumps to the “optional standby” system.

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

A. Pre-installation meetings
1. Discuss “Design/Performance Requirements” above with contractors to ensure that field changes do not change Owner requirements.
2. Discuss subsoil drainage installation in foundation waterproofing pre-installation meeting.
3. Discuss roof and overflow drain installation in roofing pre-installation meeting.

PART 2 PROVIDERS & PRODUCTS
2.1 MANUFACTURERS

A. Specify products from the following manufacturers based on local representation and support. Submit other manufacturers with local representation and support to the WU PM for approval.
   1. Cast iron pipe and fittings: AB&I Foundry, Charlotte Pipe and Foundry, Tyler Pipe
   2. No hub couplings: Anaco/Husky, Ideal Clamps, Tyler Pipe, Mission Rubber Company, Thermafit Industries POC
   3. Drainage products: J.R. Smith, MIFAB, Wade, Zurn
   4. Sump pumps: Hydromatic, Weil, Zoeller

2.2 MATERIALS

A. Specify materials, insulation, valves, and other items per the applicable Schedule.

PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS

A. Include the following text in the appropriate section of the project specifications.
   1. Cast iron pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute® and listed by NSF® International.
   2. Contractor shall verify the existing system for sizes, direction of flow, materials, and elevations before installing new work which ties into existing systems. Contractor shall notify Architect/Engineer upon discovery of any discrepancy. Contractor shall correct work performed prior to verification at no cost to Owner. Contractor shall verify by camera, sonde locate, or ground penetrating radar existing underground piping prior to excavation.
   3. Contractor shall install buried PVC pipe in accordance with ASTM F 1668.
The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Water softeners
   2. Domestic water heaters
   3. Domestic water heat exchangers

B. Related sections
   1. Section 22 05 00 & 23 05 00 “Common Work Results for Plumbing & HVAC”
   2. Section 22 07 00 & 23 07 00 “Insulation for Plumbing & HVAC”
   3. Section 22 11 00 “Facility Water Distribution”
   4. Section 33 00 00 “Campus Utility Services”
   5. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. General
   1. Water supply information is contained in related sections.
   2. Indicate shut off valves for each equipment connection to allow impact of service/replacement.
   3. Physically locate equipment to allow for working clearances and for eventual replacement without impacting other systems or building elements.
   4. Specify a housekeeping pad beneath all floor mounted equipment.
   5. See Part 2 for WU’s sole source water treatment vendor.

B. Water softeners
   1. Do not specify water softeners for typical academic buildings. Discuss special cases with WU PM.
   2. Typically, specify water softeners for Residential Building hot water, boiler makeup, and where required for process loads.
   3. WU prefers alternating twin or progressive twin water softeners.

C. Domestic hot water
   2. Produce hot water independent of building heating water or campus heating sources using heat pumps (air-water or water-water) or condensing water heaters.
   3. Consider point-of-use systems for remote loads or infrequent usage to minimize piping losses.
   4. Preheat typically utilizes heat recovery sources.
   5. Specify electric water heaters with ultra-low watt density heating elements to reduce scale buildup.
   6. Specify a floor drain near water heaters to allowing draining and service.
D. Heat exchangers
   1. Specify heat exchangers for domestic hot water only when preheating make up water to the domestic hot water system when utilizing building/campus heating water produced with a heat recovery chiller. Size the domestic water heaters for the case when the heat recovery chiller is unavailable for preheat.
   2. When utilizing brazed plate heat exchangers, specify 20-mesh or larger strainers on each inlet and coordinate the plate spacing to pass particles 50% larger than the strainer openings. Specify service valves to allow isolation and strainer cleaning.

1.3 WARRANTY, START UP, COMMISSIONING, & MAINTENANCE REQUIREMENTS

   A. Specify a 5-year parts and labor warranty on heat pump compressors.

PART 2 PROVIDERS & PRODUCTS

2.1 SOLE SOURCE WATER TREATMENT PROVIDER

   A. Chemtron RiverBend
      636-940-5445
      www.crbwater.com
      Amy Pollok (314-809-6638, amyp@crbwater.com)

2.2 MANUFACTURERS

   A. Specify products from the following manufacturers based on local representation and support. Submit other manufacturers with local representation and support to the WU PM for approval.
      1. Water softeners: Consult with sole source provider.
      2. Water heater (gas): Aerco, A.O. Smith/State, Bock, Lochinvar, PVI, RBI, Rheem/Ruud
      4. Water heaters (heat pump air to water): A.O. Smith/State, Rheem
      5. Water heaters (heat pump water to water): Colmac
      6. Tankless water heaters (gas): HTP, Lochinvar, Navien, Nortiz, Ruud, State/Takagi
      7. Tankless water heaters (electric): Chronomite Laboratories, Keltech, Rheem, State, Stiebel Eltron

PART 3 EXECUTION – NOT USED
PLUMBING FIXTURES

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Water closets and urinals
   2. Lavatories and sinks
   3. Faucets, supplies, and trim
   4. Flushometers
   5. Electric water coolers
   6. Showers
   7. Emergency face/eyewash
   8. Emergency showers

B. Related sections
   1. Section 22 11 00 “Facility Water Distribution”
   2. Section 22 13 00 “Facility Sanitary Sewerage”
   3. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. General
   1. Specify low flow, EPA WaterSense fixtures or better
      a. Water closets: 1.28 gal/flush
      b. Urinals: 0.125 gal/flush (waterless urinals are not acceptable)
      c. Lavatories: 0.5 GPM
      d. Showers: 1.75 GPM
   2. Specify automatic, hardwired fixtures in restrooms.
   4. Locate transformers for automatic fixtures above the ceiling in the corridor outside of restrooms.
      Specify transformers below 50 VA and additional transformers if needed.
   5. Specify single handle faucets when a manual faucet is required.
   6. Specify ball valve angle stops with soldered inlet, compression outlet, and shielded loose key for all lavatories and sinks.
   7. Specify carriers for all water closets, urinals, and wall mounted sinks.
   8. Specify heavy duty commercial water closet seats with solid plastic, open front less cover for elongated bowl, integral bumpers, and external check hinges with stainless steel hinge pins and mounting bolts.
   9. Specify shower valves with integral service stops.
10. ADA showers do not require a fixed shower head. Specify a hand spray unit and adjustable bar in accordance with ADA requirements.

11. Specify electric water coolers with an integral bottle filler. WU prefers surface mounted coolers over fully recessed coolers.

12. Specify freeze proof exterior hose bibs in lockable, hinged boxes. Provide service valve at the branch connection to the main to allow service.

13. Specify a laundry tub in boiler rooms, chiller rooms, and major mechanical rooms.

14. Specify a molded stone one piece basin with one piece stainless steel splash panels in janitor closets.

15. Specify stainless steel sinks as 18 gauge, type 304 stainless steel.

16. Do not specify anti-microbial finishes.

17. Specify tamper resistant fasteners.

18. Include a plumbing schedule on the drawings with an image of the fixture.

19. Include cut sheets and list prices of all plumbing fixtures in the specifications.

B. Emergency fixtures

1. Review all emergency fixture requirements with the WU PM and WU EH&S.

2. Supply emergency fixtures with tepid water between 80-100°F and locate per ANSI guidelines for the chemicals and exposure.

3. Where appropriate for the exposure, specify combination face/eye drench hoses at a sink.

4. When the chemicals and exposure require a safety shower, locate the shower within a 10 second travel distance with an unobstructed path.

1.3 WARRANTY, START UP, COMMISSIONING, & MAINTENANCE REQUIREMENTS

A. Startup

1. Specify settings for automatic devices and require contractors set/check each device.

PART 2 PROVIDERS & PRODUCTS

2.1 MANUFACTURERS

A. Specify products from the following manufacturers based on local representation and support. Submit other manufacturers with local representation and support to the WU PM for approval.

1. Vitreous china fixtures: American Standard, Kohler, Mansfield, Zurn, Sloan, Toto

2. Stainless steel sinks: Elkay, Just

3. Carriers: Josam, J.R. Smith, MIFAB, Wade, Watts, Zurn

4. Automatic flushometers: Sloan, Zurn

5. Water closet seats: American Standard, Bemis, Church, Zurn


7. Automatic faucets: Chicago, Sloan, T&S Brass, Zurn

8. Supplies: Chicago, McGuire, T&S Brass

9. Electric water coolers: Elkay, Halsey Taylor, Oasis

10. Shower valves: Symmons Safetymix (no substitutions allowed)


PART 3 EXECUTION – NOT USED
The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Heating water piping
   2. Chilled water piping
   3. Cooling condensate piping
   4. Condenser water piping
   5. Steam piping
   6. Steam condensate piping
   7. Steam traps
   8. Air separators
   9. Expansion tanks
   10. Backflow preventers
   11. Water meters
   12. Water pressure-reducing valves
   13. Circulation pumps
   14. Centrifugal pumps
   15. Pump suction diffusers
   16. Buffer tanks

B. Related sections
   1. Section 22 05 00 & 23 05 00 “Common Work Results for Plumbing & HVAC”
   2. Section 22 07 00 & 23 07 00 “Insulation for Plumbing & HVAC”
   3. Section 22 11 00 “Facility Water Distribution”
   4. Section 33 00 00 “Campus Utility Services”
   5. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Piping general
   1. Locate utility entrance piping to avoid high finish areas, stairs, retaining walls, and other locations where excavation and site restoration is difficult and more expensive.
   2. Design system to allow risers to occur at permanent structural elements of the building, such as exterior walls, columns, or chases at elevators or stairs to prevent relocation during subsequent renovations.
   3. Design for service and maintenance as key objectives.
   4. Specify a generous quantity of service valves to allow maintenance without impacting large areas of the building. Provide valves for each floor, provide valves at major branches, office suites, etc.
5. Include pipes insulation thickness for spatial planning and clash detection.

B. Coordinate with Plumbing Engineer to specify non-freeze roof hydrant at roof mounted HVAC equipment, solar panels, and other locations requiring water for maintenance.

C. Pumps
   1. Specify two pumps in parallel at 50% of the system flow at the system head for building heating and cooling HVAC pumps.
   2. Specify two pumps in parallel at 50% each or N+1 for process pumps or similar applications to allow pump maintenance. Coordinate with WU for N+1 applications.
   3. Do not specify balance valves for pumps with VFDs.
   4. Do not specify triple duty valves.
   5. Locate pumps to allow maintenance to the pump, valves, motor, strainer/suction diffuser, and VFD. Indicate all required service clearances on the mechanical plans.
   6. Select pumps to meet the following criteria:
      a. High efficiency pumps over low first cost pumps based on life cycle energy costs.
      b. Non-overloading motor size for the impeller size.
      c. Ensure parallel pumps operate on the manufacturer’s curve when operating on a single pump.
   7. Preferred pump speed is 1750 RPM, then 1150 RPM, then 3500 RPM. Coordinate with acoustic consultant when using 3500 RPM pumps.
   8. WU prefers ground mounted vertical inline pumps over end suction pumps.
   9. Specify split coupled vertical inline pumps when pump size is 3HP and larger.
   10. Do not specify inertia isolation bases for pumps installed on slab on grade unless the designer demonstrates a specific need. When inertia isolation bases are required, specify the base and draw to scale on the construction drawings. Delegated design is not acceptable.
   11. Specify a wye strainer on the pump suction of inline circulator pumps.
   12. Indicate gauge cocks for pressure measurement on each side of the pump and strainers. Indicate taps on the piping when pressure taps are not integral to the pump and/or strainer.

D. Pump suction diffusers
   1. Specify suction diffusers for end suction pumps and floor mounted inline pumps where the overhead piping drops directly to the pump inlet.
   2. Coordinate the pump inlet size and system piping. Indicate a reducer at the inlet of a suction diffuser when the largest system pipe size available is smaller than the system pipe.
   3. WU prefers a grooved system connection as part of the two flexible grooved couplings on each side of the pump.

E. Strainers
   1. Specify strainers at key locations only to minimize maintenance and troubleshooting.
   2. The pump strainer is the only strainer required for typical building hydronic systems.
   3. Do not locate strainers at control valves or coils.
   4. Design for isolation of wye and basket strainers for cleaning. If the process must run continually, specify parallel strainers. WU prefers field piped parallel strainers over duplex strainer assemblies.
   5. WU prefers single bolt clamp covers or tool free covers on basket strainers.
   6. Specify strainers on the entering flow of each side of plate frame and brazed plate heat exchangers. Coordinate the strainer mesh size to be less than the plate spacing and indicate on the drawings.

F. Air separators
   1. Specify a 2” air separator in a side stream arrangement for 5” piping and larger.
   2. Specify line size air separators for 4” piping and smaller.
3. Draw the air separator and automatic air vent to scale to allow adequate vertical height. Where line size coalescing air or air/dirt separators are used, specify service valves on each side to allow removal and 1/4” ball valves on each side to allow pressure readings.

4. On heating water systems, locate the air separator on the supply piping and before the pumps (warmest water and lowest pressure for decreased air solubility).

5. On chilled water systems, locate the air separator on the return piping and before the pumps (warmest water and lowest pressure for decreased air solubility).

G. Air vents and drains
   1. Specify high capacity automatic air vents at air separators. Specify a service valve between the air separator and the automatic air vent to allow servicing the air vent. Indicate on the drawings for the automatic air vent discharge to pipe to a floor drain.
   2. Specify manual air vents at high points, potential air pockets, and at the high point on the equipment side of service valves. Specify manual air vents valves with hose end adapter, cap, and chain.
   3. Plan for typical maintenance and locate drain valves and air vents downstream of service valves that segregate the system by floors, wings, mechanical rooms, etc.

H. Expansion tanks
   1. Specify replaceable, bladder type expansion tanks. Diaphragm type and air interface type are not acceptable.
   2. WU prefers floor mounted vertical tanks.
   3. Indicate the design charge pressure on the drawings. Provide approximately 10 psig of static pressure at the highest point in the system.
   4. Specify a 125 psig ASME stamped expansion tank for local heating hot water systems.
   5. Specify a 125 psig ASME stamped expansion tank for chilled water systems with chillers.
   6. Specify a 3/4” pressure relief valve at 125 psig for buildings without a chiller. Do not specify an expansion tank.
   7. Specify a 125 psig ASME stamped expansion tank for closed condenser water systems.
   8. Do not specify an expansion tank for open condenser water systems.
   9. Size the expansion tank by subtracting the pump head from the relief valve setting and subtracting 5 psi safety for the maximum pressure at the expansion tank.
   10. Locate the expansion tank connection, makeup water connection, and air separator in close proximity to each other to allow the minimum operating pressure at the tank to equal the fill pressure.
   11. At each expansion tank, detail an isolation valve with a hose end drain valve located between the isolation valve and tank to recharge the tank. Additionally, specify a valve at point of connection to the system piping.

I. Makeup water
   1. Provide makeup water for building HVAC systems independent from the campus loop.
   2. Local makeup water is not required for campus chilled water or campus heating water.
   3. Coordinate with plumbing engineer to specify a backflow preventer for HVAC makeup water. WU prefers a single backflow preventer for HVAC makeup with an independent service valve, check valve, and water meter for each system.
   4. Specify a single pressure regulator after the backflow preventer when the systems will operate at the same pressures.
   5. Specify separate pressure regulators if multiple systems require separate pressures.
   6. Specify BAS monitoring of makeup water meters for leak detection.

J. Steam and condensate piping
1. Design steam and condensate piping to include slope, preferably in the direction of flow. Limit the steam velocity when condensate flows the opposite direction of the steam.

2. Specify insulation and draw accurately in models and on plans.

3. Design steam piping to minimize the number of steam traps and limit the number of rises requiring additional steam traps.

4. Indicate gate valve stems on the plans to account for the required space. When a valve must be rolled, specify the angle based on the flange bolt pattern and which provides two bolt holes flat on top (not one bolt hole on top).

K. Steam traps
   1. Tag and schedule all condensate traps with a unique plan ID. Indicate the load, inlet pressure, and back pressure on the schedule.

L. Steam condensate pumps
   1. Apply engineering judgement to steam condensate temperature at the pump/receiver. If the loads are in close proximity to the receiver, consider the condensate as 210°F. If the loads are not in close proximity to the receiver, consider the condensate as 200°F.
   2. Specify stainless steel receiver tanks for corrosion resistance.
   3. Specify duplex pumps in a duty/standby configuration.
   4. Specify a vent through the roof.
   5. Specify a steam trap overflow.

PART 2 PROVIDERS & PRODUCTS

2.1 SOLE SOURCE STEAM TRAP PROVIDER

   A. Steam Management Systems, Inc.
      314-644-5988
      www.steamms.com

2.2 MANUFACTURERS

   A. Specify products from the following manufacturers based on local representation and support. Submit other manufacturers with local representation and support to the WU PM for approval.
      1. Pumps: Armstrong, Bell & Gossett, Grundfos, Taco
      2. Air separators: Armstrong, Bell & Gossett, Taco, Spirotherm, Wessels
      3. Expansion tanks: Armstrong, Amtrol, Bell & Gossett, Taco, Wessels

2.3 MATERIALS

   A. Specify materials, insulation, valves, and other items per the applicable Schedule.

   B. Specify pre-insulated steam piping conduit systems as follows:
      1. Steel carrier pipe, mineral wool insulation, air space, 10 ga steel conduit, polyurethane foam insulation
      2. HDPE jacket and pressure testable jacket joints
      3. No exposed metal or exposed epoxy coating
4. Acceptable materials
   a. Perma-Pipe: Multi-Therm 500
   b. Rovanco: Insul 800
   c. Thermacor: Duo-Therm 505

C. Specify pre-insulated heating water (180°F+) and pump steam condensate piping systems as follows:
   1. Steel carrier pipe (see Pipe Schedule), polyurethane foam insulation
   2. HDPE jacket and pressure testable jacket joints
   3. No exposed metal or exposed epoxy coating
   4. Acceptable materials
      a. Perma-Pipe: Xtru-Therm
      b. Rovanco: HDPE Jacketed System
      c. Thermacor: Ferro-Therm

D. Specify pre-insulated heating water (less than 180°F) piping systems as follows:
   1. PE-RT carrier pipe, polyurethane foam insulation
   2. HDPE jacket (jacket not required to be pressure testable due to non-ferrous carrier pipe)
   3. Acceptable materials
      a. Thermacor: Polycor Platinum
      b. Rovanco: Equivalent to Thermacor Polycor Platinum
      c. Thermacor: Equivalent to Thermacor Polycor Platinum

E. Steam traps
   1. Specify orifice type drip traps.
   2. Specify Duo-Dynamic models for modulating loads.
   3. Specify steam traps from WU’s sole source provider.

PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS

A. Include the following text in the appropriate section of the project specifications:
   1. Contractor shall provide pumps which meet the following criteria:
      a. High pump efficiency: Selections with pump efficiencies 5% less than the scheduled pump may be rejected.
      b. Non-overloading motor size for the impeller size: Selections with overloading motors may be rejected.
      c. Parallel pumps shall remain on the manufacturer’s published curve when operating on a single pump. Selections off the published curve may be rejected.
   2. Contractor shall verify existing systems for sizes, capacity, materials, and elevations before installing new work which ties into existing systems. Contractor shall notify Architect/Engineer upon discovery of any discrepancy. Contractor shall correct work performed prior to verification at no cost to Owner.
   3. Contractor shall provide start-up strainers at existing pumps strainers prior to working on existing piping systems.
   4. Contractor shall keep startup strainers in place until Owner accepts pipe cleaning and flushing. Contractor shall affix start up strainers to pump valve so Owner and Engineer can confirm that start-up strainers have been removed.
5. Contractor shall install underground HDPE piping systems with butt fusion joints. Contractor shall not use electrofusion couplings. Contractor shall include excavation and other requirements needed for in-trench butt fusion welding.
The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1  GENERAL

1.1 SUMMARY
A. Section includes
   1. HVAC ducts
   2. Air plenums
   3. Air duct accessories
   4. HVAC fans
   5. Special exhaust systems
   6. Air terminal units
   7. Ventilation hoods
   8. Louvers
   9. Air filtration
B. Related sections
   1. Section 22 05 00 & 23 05 00 “Common Work Results for Plumbing & HVAC”
   2. Section 33 00 00 “Campus Utility Services”
   3. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS
A. HVAC ducts
   1. Specify interior duct material as follows:
      a. Dry and non-corrosive: G90 sheet metal or phenolic duct
      b. Wet/moist: Aluminum, stainless steel, or phenolic duct
      c. Corrosive: Stainless steel
      d. Kitchen exhaust: Welded black iron or listed grease duct
   2. Specify exterior duct material as follows:
      a. Dry and non-corrosive: Round aluminum, round stainless steel, or vinyl clad phenolic duct
      b. Wet/moist: Round aluminum, round stainless steel, or vinyl clad phenolic duct
      c. Corrosive: Round stainless steel
      d. Round metal duct with insulation: Specify double wall duct with exterior shell as aluminum or stainless steel for weather protection and compatible with system air type.
   3. Do not specify fiberglass duct board.
   4. Design HVAC ductwork for low pressure drop for energy conservation.
      a. Limit friction factor to 0.10" w.c. per 100’ unless submitting a life cycle cost analysis to WU.
      b. Evaluate radiusied elbows in portions of the system with higher velocity and larger area.
      c. Utilize proportional splits in lieu of takeoff fittings in branches with greater than 25% of airflow.
      d. Specify low-loss, 45° boot or conical takeoff fittings. Spin-in takeoffs are not acceptable.
e. Submit duct static pressure calculations for final WU Document Review package. Indicate duct size, airflow, velocity, and friction factor of each duct segment on construction documents.

5. Rectangular ducts
   a. Specify “Pittsburgh Lock” longitudinal duct joints. Snaplock joints are not acceptable.
   b. Specify Ductmate, SMACNA T-25, or approved equivalent for transverse joints 48” and larger.
   c. Specify SMACNA-approved joints suitable for the pressure class for transverse joints less than 48”.
   d. Specify 90° elbows as mitered with turning vanes or radiused with center line radius to width ratio of 0.75 (inside radius/width ratio 0.25 with curve ratio 0.585) with 2 splitter vanes.
   e. Specify 45° and less elbows as mitered without vanes.
   f. Specify other elbows as radiused with centerline radius to width ratio of 1.0 without splitter vanes.

6. Round ducts and flat oval ducts
   a. Specify spiral seams or continuously welded longitudinal seams.
   b. Specify Ductmate or approved equivalent for transverse joints in 24” and larger ducts.
   c. Specify beaded sleeve transverse joints for ductwork smaller than 24”.
   d. Design elbows and changes in direction with a minimum centerline radius of 1.5x the duct size.
   e. Specify branch take-off as 45° booted style, similar to McGill Airflow Lo-Loss Tee.

7. Indicate on the drawings material type and wall construction changes within the same system.

8. Pressure class
   a. Specify 2” pressure class for terminal equipment, fans, or equipment operating less than 2” w.c.
   b. Specify 4” pressure class for central air handling units, fans, or equipment operating at 2” w.c. or greater.

9. Seal class
   a. Specify seal class A for 4” pressure class, all exterior duct, and ASHRAE 62.1 class 3 or class 4 air.
   b. Specify seal class B for 2” pressure class except when the terminal equipment is in the room served.
   c. Specify seal class C for 2” pressure class and when the terminal equipment is in the room served.

10. Maintenance access and duct protection
    a. Design walk paths for duct installed less than 6’ AFF that do not cross over or under ductwork.
    b. Design stairs to cross over duct that which is unnavigable otherwise.

B. Transfer ducts
    1. Size transfer openings and ducts for low pressure drop considering the sum of all series paths.
    2. Design large acoustical rated transfer ducts with z-shape and 1” acoustical liner.
    3. Design small acoustical rated transfer ducts using 5’ maximum flexible duct with an elbow.

C. Air plenums
    1. Indicate an access door conforming to the requirements below for plenums requiring access.
    2. Specify sheet metal bracing and reinforcement to support the weight of a 250 lb. person. Do not specify or permit tie rods. Specify external insulation.
    3. Specify sloped bottoms which drain through a weep at the face of the louver for outdoor air louver plenums.

D. Duct liner
    1. Duct lining is acceptable in academic and residential spaces.
    2. Duct lining is not acceptable in laboratory, medical/healthcare, or research spaces.
    3. Specify pinned and glued liner in accordance with SMANCA standards.
    4. Specify metal nosing at the transition between lined duct and unlined duct or equipment.
E. HVAC fans
1. Indicate the required service clearance on the drawings.
2. Layout fans to facilitate fan maintenance, including belt and motor replacement. Indicate an access panel for motor replacement of housed direct drive fans.
3. Select fans which do not operate within 15% of the maximum or minimum allowable RPM. Where selection point is within 15% of the maximum allowable RPM, specify a higher fan class.
4. Specify an EC motor or VFD for direct drive fans to match the fan speed to the system requirements.
5. Select fans meeting the following criteria:
   a. High efficiency
   b. Quiet operation
   c. Stable operation, selected to the right of the surge line, typically 1 or 2 wheel diameters smaller than optimal
   d. Non-overloading motor anywhere along the rpm curve
6. Locate motorized backdraft dampers, as required by ASHRAE 90.1, to allow service access to the damper and actuator. WU prefers indoor dampers for roof-mounted fans with an actuator hardwired to the fan starter/VFD with an end switch required to prove open before the fan starts.
7. Laboratory exhaust systems
   a. Evaluate the exhaust plume for the building and adjacent buildings. Discuss wind tunnel testing with the WU PM.
   b. See Part 2 for WU’s preferred firm for exhaust plume and wind tunnel testing.
   c. Typically, design building laboratory exhaust systems with multiple fans on a plenum with N+1 redundancy.
   d. Specify a standby power source for laboratory exhaust fans. Consult with the WU PM to determine if makeup air and pre-heat require a standby power source.

F. Balance dampers
1. Indicate on the drawings volume dampers at each main branch take-off and other locations where required to properly balance the air distribution systems. Do not indicate dampers at take-offs to VAV box inlets.
2. Specify frames, bearings, and quadrant lock regulators with thread screw to allow damper locking for all dampers, except those located downstream from terminal units used to adjust individual grilles.
3. Specify 18 ga. minimum plate, 3/8” continuous shaft, and locking quadrant handle equal to Duro Dyne “Quadline” for contractor fabricated or manufactured branch fitting balancing dampers downstream from terminal units.

G. Fire dampers
1. Indicate on the drawings all required fire dampers.
2. Identify and schedule all fire dampers with a unique number.
3. Specify fire damper blades out of the air stream.
4. Indicate on the drawings the location and size of access doors at all fire damper locations.

H. Fire/smoke dampers
1. Indicate on the drawings the locations of all required fire/smoke dampers.
2. Identify and schedule all fire/smoke dampers with a unique number.
3. Specify direct coupled actuators with the damper blades and actuator outside of the wall but within the length of the sleeve.
4. Indicate on the drawings the location and size of access doors at all fire/smoke damper locations.
5. Coordinate with Division 26 to indicate the power requirements and fire alarm control modules.
6. Coordinate with Division 26 to specify the fire/smoke damper control and shutdown sequences. Typically, WU does not shut down an entire building based on a fire/smoke alarm.

I. Access panel
   1. Indicate on the drawings access panels at all fire dampers, control dampers, airflow stations, entering side of duct mounted coils, leaving side of duct mounted trim humidifiers, etc.
   2. Specify the largest access panel size that the duct allows. Minimum access panel size is 6” x 6”.

J. Access door
   1. Indicate access doors at all plenum boxes and at any location requiring personnel access.
   2. Minimum access door size is 18” x 36”.

K. Turning vanes
   1. Specify air turning vanes for all 90° changes in direction for supply, return, relief, and exhaust duct unless prohibited by code.
   2. Specify single thickness, 2” radius, 1.5” on-center turning vanes.

L. Flexible air duct
   1. Specify 8’ max length for diffusers and 3’ max length for VAV box inlets.
   2. Specify duct support at 4’ OC maximum.
   3. Specify UL listed, plenum rated zip-tie on duct in lieu of over the insulation.
   4. Specify a metallic vapor barrier for cooling ducts.
   5. Specify an elbow support product at elbow connections to ceiling diffusers.

M. Variable Air Volume (VAV) & Constant Air Volume (CAV) terminal units
   1. Ensure spaces have a similar exposure and usage prior to specifying a single terminal unit.
   2. Review with the WU PM the maximum number of zones on a single terminal unit. Submit proposed zoning diagrams for WU review prior to SD submission.
   3. Ensure a 36” deep access area in front of control panel free from light fixtures, sprinkler heads, speakers, or other equipment which may limit access.
   4. Size the downstream size of the takeoff fittings as the box inlet size only if the connection is hard duct, straight, and less than 15’ long. Otherwise, size the duct downstream of the takeoff fitting for a maximum pressure drop of 0.10” w.c. per 100’ and reduce to terminal unit inlet size 30” upstream of unit or 2.5 duct diameters, whichever is greater.
   5. Coordinate terminal unit insulation liner with duct insulation. Specify a fiberglass liner for systems with internal duct liner and specify a double wall, fiber free, or foil faced liner for systems with external duct insulation.

N. Ventilation hoods
   1. Locate intake hoods and relief hoods to eliminate cross contamination. Locate intake hoods 15’ minimum away from exhaust air, relief air, plumbing vents, generator exhaust, loading docks, and delivery/service points. Consider prevailing wind patterns and rooftop dead zones.
   2. Locate intake hoods and relief hoods away from walls or parapets where snow drift can form.
   3. Specify 18” high minimum curbs.

O. Louvers
   1. Locate intake hoods and relief hoods to eliminate cross contamination. Locate intake louvers 15’ minimum away from exhaust air, relief air, plumbing vents, generator exhaust, loading docks, and delivery/service points. Consider prevailing wind patterns and rooftop dead zones.
   2. Specify louvers as wind driven rain resistant type AMCA class A at 30 mph and 50 mph test and with a pressure drop less than 0.15” w.c.
3. In area wells, locate louvers 18” minimum above the bottom of the area well. Detail an 18” minimum deep plenum box with access doors to allow inspection and cleaning when louvers connect to duct work. For duct connections to a plenum, detail 6” minimum from the bottom of the duct to the bottom of the plenum.

4. Specify rear framed bird screens on louvers for system with filters. Specify insect screens only when the louver is directly open to an interior space. Indicate plenum access for inspection and cleaning.

5. Coordinate louver size, locations, and mounting details with the Architect.

6. Specify louver finish as Kynar 500 with a dry film thickness of 1.2 mils and 20 year finish warranty. Specify color selection from manufacturer's standard colors at time of shop drawing submittals.

7. Specify mechanical system louvers either in Division 24 or coordinate with the Architect and specify in Division 7.

P. Air filtration

1. Specify 24” x 24” and 12” x 24” filters where possible to minimize inventory requirements.

2. When central station air handling units do not use the sizes above, specify an external filter rack such as Camfil GlidePack MultiTrack 25 or equal utilizing a filter velocity between 350-450 fpm.

3. Specify Camfil Hi-Flow ES filters without a pre-filter at central station air handling units. With initial resistance less than 0.5” w.c., allow 1.0” w.c. of external static for change out of dirty filters.

PART 2 PROVIDERS & PRODUCTS

2.1 PREFERRED EXHAUST PLUME & WIND TUNNEL TESTING CONSULTANT

A. Cermak, Peterka, Petersen (CPP) Inc.
970-221-3371
www.cppwind.com

2.2 MANUFACTURERS

A. Specify products from the following manufacturers based on local representation and support. Submit other manufacturers with local representation and support to the WU PM for approval.

1. Centrifugal fans and vent sets: Cook, Greenheck, Twin City, ACME

2. Lab exhaust (variable volume): Cook, Greenheck, MK Plastics, Strobic Air


4. Fire dampers: Ruskin, Nailor, Air Balance, Greenheck

5. Access doors and panels: Ruskin, Nailor, Ductmate

6. Intake and relief hoods: Greenheck, Ruskin, Penn Ventilation, United Enertech

7. Louvers: Ruskin, Greenheck, Air Balance, Arrow, NCA, United Enertech

8. Air filters (central station AHU): Camfil Hi-Flow ES, Koch Multi-Sak

9. Air filter (terminal equipment): American Air Filter, Camfil, Koch

PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS

A. Include the following text in the appropriate section of the projection specifications:

1. Contractor shall provide fans which meet the following criteria:
a. High Fan Efficiency: Selections with fan efficiencies 5% less than the scheduled fan may be rejected.
b. Non-overloading motor size for the wheel size: Selections with overloading motors may be rejected.
c. The fan RPM selection point shall not be within 15% of the maximum or minimum allowable rpm; where selection point is within 15% of the maximum allowable rpm of the fan class, provide a higher fan class.

2. Contractor shall provide all flanged ductwork, regardless of pressure class, with gaskets, corner closures, and screws or rivets at 10” on centers with a minimum of two (2) per side.

3. Contractor shall provide fans licensed to bear the AMCA Performance Air and Sound Certified Ratings Seal. Fan air performance ratings shall be based on test conducted in an AMCA registered laboratory in accordance with AMCA 210 Air Performance Testing and AMCA 300 Sound Performance Testing. Fan curve families (tables will not be accepted) and octave band sound data shall be furnished with submittal data.

4. Contractor shall provide fans with induced air outlets having performance ratings based on tests conducted in an AMCA registered laboratory in accordance with AMCA 260 Laboratory Methods of Testing Induced Flow Fans for Rating.

5. Where louvers must be made up by multiple sections, the Contractor shall submit shop drawings showing, all joint locations and methods of bracing/assembly. When the louvers are assembled per the shop drawings they shall meet the specified structural loading.

6. Fire dampers shall be tested by the Contractor and witnessed by the Owner. The Contractor shall remove the fusible link and demonstrate that the damper closes freely. After acceptance by the Owner, the Contractor shall reset the damper and replace the fusible link.

7. Smoke dampers and/or fire/smoke dampers shall be tested by the Contractor and witnessed by the Owner. The Contractor shall operate and demonstrate that the damper closes freely. After acceptance by the Owner, the Contractor shall reset the damper to normal operation.

8. For roof mounted fans, Contractor shall install a stainless steel cable from the motor cover to the base to allow the motor cover to be removed for service but prevents the cover from being blown away. Cable shall have eyelet or swaged ends with stainless steel hardware.

9. Contractor shall repair or replace duct liner with rips, cut, tears, or abrasions with a new section of duct with undamaged liner.

10. Contractor shall implement procedures to maintain an “Advanced Level” of ductwork cleanliness per the latest addition of the SMACNA Duct Cleanliness for New Construction Guidelines.
   a. Production and site delivery:
      1) Self-adhesive labels for part of identification are to be applied to the external surfaces only.
      2) During transportation, ductwork and air distribution components shall be sealed either by blanketing or capping the duct ends, bagging small fittings, surface wrapping or shrink wrapping.
   b. Site storage:
      1) Temporary storage shall be located away from high dust generating processes such as masonry, tile cutters, saws, drywall sanding, mortar and plaster mixers, roof pitch kettles, portable electric generators, and main walkways that will be constantly broom swept.
      2) Temporary storage shall include pallets or blocking to keep ductwork and air distribution components above floor surface to prevent water damage.
      3) Coverage should always be used to protect stored materials.
      4) Duct open ends and air side of air distribution components shall always be securely sealed.
      5) Seals shall be visually examined and if damaged, resealed with an appropriate material.
   c. Installation:
1) Before installation of individual duct sections and air distribution components, they are to be inspected to ensure that they are free from debris and shall be wiped clean if debris exists.
2) The working area shall be clean, dry, and the airside of ductwork and air distribution components protected from dust and moisture.
3) Protective coverings shall only be removed immediately before installation and inspected to determine if additional wipe down is necessary.
4) Open ends on completed ductwork shall be sealed immediately if left for an extended period (work breaks, overnight, etc.).
The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Packaged water chillers

B. Related sections
   1. Section 03 00 00 “Concrete”
   2. Section 22 05 00 & 23 05 00 “Common Work Results for Plumbing & HVAC”
   3. Section 23 20 00 “HVAC Piping and Pumps”
   4. Section 26 05 00 “Common Work Results for Electrical”
   5. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Specify chiller refrigerant in accordance with LEED Fundamental and Enhanced Refrigeration credits. WU prefers refrigerants with an ozone depletion value of 0 and low global warming potential.

B. WU prefers to procure chillers based on life cycle bidding using the expected chiller load profile.

C. Maintenance considerations
   1. Design chiller room to accommodate tube pull space and chiller replacement.
   2. Locate chillers at grade level or basement level adjacent to an exterior wall for easy replacement without chiller disassembly, ductwork removal, or piping removal.
   3. Coordinate with the architect to provide an overhead door, removable louver, or removable panel for chiller removal.
   4. Coordinate with the architect to provide an area way for below grade chillers.
   5. Coordinate with the architect to provide crane access from a roadway or fire lane to facilitate replacement.
   6. Coordinate with project team to ensure piping, ductwork, and electrical systems allow removal of the chiller compressor and motor with an A-frame hoist.
   7. Do not route or allow plumbing lines below chillers.

D. Sound and vibration considerations
   1. On occasion, acoustic consultant recommendations have been overly conservative and resulted in non-typical installations for WU. The acoustic consultant shall review the requirements for vibration isolation of rotating equipment with the mechanical consultant and WU PM at milestone reviews.
   2. Avoid locating chillers adjacent to vibration or acoustic sensitive spaces.
   3. WU prefers thickened mechanical room slabs on grade isolated from the basement slab to mitigate vibration sources for the current design and future equipment or renovations. With the isolated mechanical room slab, strip pads under the tube sheet are adequate.
4. Housekeeping pads and neoprene pads are typically acceptable for non-VFD chillers installed at slabs on grade. Specify spring isolation only when the Acoustic Consultant demonstrates the need.

5. VFD chillers may excite frequencies in the building structure. Specify spring isolation if the mechanical room floor slab is not isolated from the building.

6. Specify spring isolation for chillers located on elevated slabs.

7. Specify braided flexible connectors for chiller refrigerant relief connections.

8. WU prefers chiller hydronic piping vibration isolation to be two flexible grooved coupling with 12” minimum separation between couplings on the equipment side of the service valve. In special cases where additional isolation is required and approved by WU PM, specify stainless steel flexible connectors. Do not specify rubber flexible connectors.

E. Piping considerations
1. Design piping to allow service valve closure, removal of piping and specialties between the service valves and chiller, and removal of water boxes.
2. Locate flanges or grooved couplings to allow removal of the minimal amount of piping to clean the chiller tubes.
3. Specify a reducer/increaser at the chiller flanges to adapt to the indicated line size when the chiller connection sizes are different than the system piping. Specify specialties and service valves corresponding to the line size, not the chiller connection size.
4. Coordinate piping with insulation and adjacent equipment locations with hinged water boxes to allow greater than 90° swing.
5. Layout piping specialties using the alternate face of vertical piping to limit intrusion into narrow aisles. Identify locations of specialties using elevation views on the construction documents.
6. Specify a single pressure gauge with gauge cocks connected with copper tubing between supply and return to allow differential pressure measurement.

F. ASHRAE-15 considerations
1. Locate the refrigerant exhaust fan on the roof to maintain negative duct pressure through the building.
2. Specify a VFD for the fan to enable occupied ventilation rate and high refrigerant exhaust rate.
3. Specify a hardwired connection to the refrigerant monitor to enable high exhaust rate.

G. Electrical considerations
1. When specifying multiple chillers and cooling towers to provide redundancy, specify a distribution panel for each chiller with associated cooling tower, pumps and accessories to allow electrical maintenance without impacting the whole system.

H. Structural considerations
1. Coordinate with Structural Consultant to identify operating weight and support information.
2. Coordinate with Structural Consultant to specify isolated mechanical room slabs on grade.

I. Seismic considerations
1. Specify an Importance Factor = 1.5 for items noted below:
   a. Refrigerant relief piping
   b. Refrigerant exhaust ductwork
   c. Makeup air to refrigerant exhaust
2. Specify seismic snubbers at four corners of centrifugal chillers and large screw chillers.

J. Chillers (all types)
1. Review special cases with WU PM.
2. Evaporator fouling factor: 0.00025
3. Condenser fouling factor (open loop): 0.0005
4. Condenser fouling factor (closed loop): 0.00025
5. Specify grooved piping connections.
6. WU prefers the refrigerants identified below. Present alternate refrigerants to WU for approval.
7. WU prefers single point power.
8. Select water cooled condensers on the Danforth chilled water system at 85°F - 95°F for summer chillers and 85°F - 100°F for chillers with extended operation for decreased condenser pump operation.
9. Select air cooled condensers at 100°F ambient or 105°F where located on black roofs, asphalt pavement, etc.
10. Select air cooled condensers at 0°F ambient with head pressure control when operated year round.
11. Specify the chiller room ambient conditions in the construction documents.

K. Centrifugal chillers
   1. Preferred refrigerants
      a. Low pressure: R-1233zd or R-514A
      b. Medium pressure: R-513A
   2. Specify marine head water boxes on both evaporator and condenser.
   3. Specify a hinged water box on open condenser water systems.
   4. Specify a self-closing type relief valve in lieu of a rupture disk on low pressure chillers.
   5. Specify 5kV chillers unit mounted across the line starter.
   6. Specify a wye-delta starter or VFD on 480V chillers

L. Screw chillers
   1. Preferred refrigerant: R-513A
   2. Specify 480V chillers with wye-delta starter or VFD.

M. Modular chillers
   1. Preferred refrigerant: R-513A
   2. Specify a fine mesh strainer on inlet to brazed plate heat exchangers.
   3. Achieve capacity control to match the load profile by specifying a VFD scroll compressor, digital scroll compressor, or screw compressors with modulation. Capacity control by staging fixed speed scroll compressors is typically not adequate.

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

A. Review the following at the pre-installation meeting:
   1. Chiller foundation installation
   2. Under slab plumbing in mechanical room
   3. Piping specialties between equipment and service valves
   4. Aisles to remain free of piping specialties

1.4 WARRANTY, START UP, COMMISSIONING, & MAINTENANCE REQUIREMENTS

A. Specify a special 5 year warranty covering parts and labor on complete chiller including refrigerant charge and oil charge.

B. Specify factory supervision for installation and startup.

C. Specify factory performed oil changes and oil analysis at 6 months and 12 months.
D. Do not specify eddy current testing, vibration testing, and motor testing. WU will separately perform these tests for baseline readings.

PART 2 PROVIDERS & PRODUCTS

2.1 MANUFACTURERS

A. Specify products from the following manufacturers based on local representation and support. Submit other manufacturers with local representation and support to the WU PM for approval.
   1. Centrifugal chillers: Carrier, Trane, York
   2. Screw chillers: Carrier, Trane, York
   3. Modular chillers: Discuss with WU PM.
   4. Seismic snubbers for chillers: Mason type Z-1011, VMC SR series

PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS

A. Include the following text in the appropriate section of the projection specifications:
   1. Contractor shall coordinate pad size with approved equipment submittal with allowance for seismic snubbers, anchor bolt requirements, pad reinforcement, pad chamfer strips, and pad doweling to floor.
   2. Contractor shall coordinate refrigerant relief piping rough-in size and location and final connection locations and quantities with approved equipment submittal.
   3. Contractor shall coordinate piping rough-in size and location and final connection locations and quantities with approved equipment submittal.
   4. Contractor shall coordinate piping location with hinged water boxes to allow greater than 90-degree swing.
   5. Contractor shall coordinate electrical rough-in size and location and final connection locations and quantities with approved equipment submittal.
   6. Chiller manufacturer shall select compressor, impeller, motor, and drive at off design conditions to prevent selections that are too close to surge or stall. Equipment selection shall be capable of operating continuously without surge or stall with unloading from 100% to 20% at the conditions below with the design waterflows. Unit shall be ARI certified for stable continuous operation through this load range. Provide the non-surge ratings with the submittal.
      a. [Design LWT - 2]°F leaving evaporator with [Design EWT]°F entering condenser; and
   7. Chiller manufacturer shall provide a BACnet MSTP communication card/gateway. The proposal and shop drawings shall clearly identify if any freestanding panels are required. The Contractor shall include power and communication wiring to freestanding panels. The manufacturer shall include the cost to coordinate the mapping of the BACnet points with the BAS contractor.
   8. Chiller manufacturer shall provide electronic thermal dispersion type flow switches. Mechanical or differential pressure flow switches are not acceptable.
   9. Contractor shall test and adjust set point for electronic flow switches for chiller minimum flow rates, or value indicated by Engineer.
The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Cooling towers

B. Related sections
   1. Section 05 00 00 “Structural and Other Steel”
   2. Section 23 20 00 “HVAC Piping and Pumps”
   3. Section 23 60 00 “Central Cooling Equipment”
   4. Section 26 05 00 “Common Work Results for Electrical”
   5. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Cooling towers on the Danforth Campus are typically roof mounted on galvanized, spring isolated, steel dunnage with architectural screening. Cooling towers off campus may be located at grade with WU approval.

B. Design criteria
   1. 79°F WB design
   2. Cross flow
   3. Specify all stainless steel or FRP construction with galvanized steel fan guard.
   4. Specify a motor-gear drive, out of the air stream, with shaft grounding rings.
   5. Specify a deep bottom sump outlet.
   6. Specify factory piped bottom or side inlets.
   7. Specify a factory installed vibration switch.
   8. Specify an extended gearbox oil fill.
   9. Specify an equalizer line between cells.
   10. Specify level sensors from the BAS contractor not the tower manufacturer.

C. Sound considerations
   1. Comply with sound ordinances at the property line.
   2. Specify towers and other mitigation measures to achieve 60 dBA at grade via the shortest path. Typically, efficient towers with low sound fans and screen walls achieve this criteria.
   3. Do not specify sound attenuators on the towers.

D. Architectural screening considerations
   1. WU prefers solid screen walls for sound mitigation.
2. Comply with the manufacturer’s requirements for the clear distance from the screen wall to the cooling tower. Typically, this distance equals the height of the cooling tower for a solid wall or proportional to the free area of the screen wall for non-solid walls.

3. Model the tower inlet piping on top of the tower, whether field piped or factory piped, to ensure the proper screen height.

E. Vibration considerations
1. Specify housed seismic springs with limit stops for roof mounted cooling towers.
2. Do not locate cooling towers above vibration- or acoustic-sensitive spaces.

F. Piping considerations
1. Design the overflow and drain piping to discharge to a sanitary standpipe. Discharging to a roof drain is not acceptable.
2. Specify rubber sphere flexible connectors from the pipe to the tower at spring-supported towers. Differentiate between roof- or ground-supported piping and dunnage-supported piping before/after the flexible connectors.
3. Locate the level sensor inside single-cell cooling towers. Locate a single level sensor on the equalizer line with a standpipe 12” above the tower waterline for multi-cell towers.
4. Design roof mounted piping 12” minimum above the finished roof, including tapered insulation, to allow re-roofing.
5. Specify Teflon slides to allow for pipe expansion.
6. Specify painting of all uninsulated ferrous piping.
7. Where ball valves are used, specify valves with a stainless steel body, vented ball type with the vent located on the drain side. Specify stainless steel nipples between tower and ball valves.

G. Freeze protection considerations
1. WU drains campus chillers and towers that only operate during the summer.
2. Do not specify freeze protection for summer chillers.
3. Specify non-ferrous condenser piping for summer chillers.
4. Specify freeze protection for towers that remain wetted year round:
   a. Specify a heat exchanger and circulating pump located in the mechanical room.
   b. Specify a 2” return bypass 2-position control valve at the cooling tower to divert water to the basin.
   c. If the tower has line size automatic cell isolation valves, locate the 2” return bypass control valve adjacent to upstream side of automatic cell isolation valves and a 1” drain 2-position control valve adjacent to downstream side of automatic cell isolation valves.
5. Specify heat trace only on equalizer piping.
6. Specify a line size 2-position bypass at the cooling tower to divert water to the cooling tower basin if the cooling tower capacity without fans exceeds the chiller heat load at low chiller load conditions during freezing ambient conditions.

H. Electrical considerations
1. Locate VFDs indoors in a mechanical or electrical room. Do not locate VFDs on the roof. Coordinate maximum wire length and desired VFD carrier frequency.
2. Design conduit pathways attached to the structure so they remain in place after tower replacement. The cooling tower may support the short feed to the motor.
3. Coordinate with electrical engineer to specify three conduits for cooling tower power, safeties, and temperature controls.
4. Specify disconnects with a switch position contact wired to the VFD safety circuit to stop the VFD when the switch is open.
5. Coordinate with electrical engineer to provide a dedicated 20A convenience outlet near cooling towers.

I. Structural considerations
   1. Coordinate with structural engineer to support cooling towers with two beams parallel to the short side of cooling tower cell and approximately 1’-6” from the edge.
   2. Coordinate with structural engineer to eliminate conflicts between lateral bracing and cooling tower underside connections. If the specific connection points are unknown, coordinate with structural engineer to design dunnage bracing which is adjustable at no extra cost to WU.
   3. Coordinate the design team to illustrate design intent and ensure design responsibility of all metal grating, ladders, handrails, and crossover walkways. Specify hot dipped galvanized or non-ferrous materials.

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS
   A. Discuss the following at pre-installation meetings:
      1. Cooling tower and piping support
      2. Cooling tower piping design objectives for draining and freeze protection
      3. Roof supports (in roofing pre-installation meetings)

1.4 WARRANTY, START UP, COMMISSIONING, & MAINTENANCE REQUIREMENTS
   A. Special warranty: Five-year parts and labor
   B. Specify factory supervision of assembly and startup.

PART 2 PROVIDERS & PRODUCTS

2.1 MANUFACTURERS
   A. Specify products from the following manufacturers based on local representation and support. Submit other manufacturers with local representation and support to the WU PM for approval.
      1. Cooling Towers: Marley-SPX, Baltimore Air Coil

PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS
   A. Include the following text in the appropriate section of the project specifications:
      1. Contractor shall coordinate with Owner’s representative to witness cooling tower spring adjustment.
INTEGRATED AUTOMATION FACILITY CONTROLS

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Integrated automation facility controls

B. Related sections
   1. Section 22 05 00 & 23 05 00 “Common Work Results for Plumbing & HVAC”
   2. Section 22 05 53 & 23 05 53 “Identification for Plumbing & HVAC”
   3. Section 26 05 00 “Common Work Results for Electrical”
   4. See the Introduction, Figures, Schedules, and Appendices for additional information.

C. Abbreviations
   1. BAS: Building Automation System
   2. JCI: Johnson Controls Inc.
   3. NAE: Network Automation Engine
   4. Refer to Section 22 05 53 & 23 05 53 “Identification for Plumbing and HVAC” for common equipment abbreviations used in this section.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. General
   1. WU uses JCI as the sole source contractor for all buildings on the Danforth Campus and most off campus commercial properties. Consult with WU PM for off campus projects.
   2. Engage JCI as a design assist partner. See Part 2 for contact information.
   3. WU maintains a master agreement with JCI covering JCI labor & material and third party labor & material.
   4. WU FPM Utilities and Maintenance groups have extensive BAS experience and infrastructure.

B. BAS system
   1. Generally, specify BAS control for all HVAC equipment. Do not specify stand-alone controls integrated with BAS.
   2. Do not specify a PC workstation, printer, and training unless specifically requested.
   3. Do not specify specific graphics screens. WU has coordinated typical graphics with JCI for systems and buildings. WU creates additional graphics on an as-needed basis.
   4. For non-JCI projects, coordinate with WU and specify specific graphics.

C. BAS control panels
   1. Indicate on the drawings the BAS control panel locations for AHU’s, boilers, chillers and other non-terminal equipment to plan for required wall space. Indicate a dedicated 20A 120V circuit for each control panel.
2. Locate BAS control panel near the controlled device for economical wiring installation.

3. Confirm with WU PM and JCI if a building NAE is required during the milestone review process. Indicate a dedicated 20A 120V circuit and network data drop for each NAE.

D. Control valves
   1. For JCI sole source projects, schedule valves as a JCI product.
   2. For non-JCI sole source project, schedule valves as a Belimo product.
   3. Specify and ensure pre-packaged equipment contains valves meeting the criteria in this section.
   4. Locate valves and actuators at locations that allow for access, maintenance, and replacement.
   5. Schedule control valves on the drawings and indicate the size, CV, valve type, shut off pressure, actuator type, and fail-safe position. For projects with 20 or more terminal units, specify typical flow ranges in lieu of scheduling individual terminal units.
   6. Specify valves for specific equipment as follows:
      a. Do not specify solenoid valves or zone valves for HVAC control.
      b. Terminal equipment: Characterized ball valves with proportional actuators
      c. Hydronic indoor AHU with unconditioned OA: Characterized ball valves with proportional actuators with spring return N.O.
      d. Hydronic indoor AHU without unconditioned OA: Characterized ball valves with proportional actuators without spring return N.C.
      e. Hydronic outdoor RTU air: Characterized ball valves with proportional actuators with spring return N.O.
      f. Steam loads: Globe valves with proportional actuators with spring return N.C.
   7. Select control valves for modulating hydronic service for 3-5 psig pressure drop.
   8. Where required, specify 2-position, line size control valves. Ball valves shall be full port.
   9. Typically, specify 2-way controls valves for energy conservation.
   10. Typically, do not specify 3-way valves very except for remote runs at temperature.
   11. Specify a 2-way valve bypass at a remote portion of the system to maximize effective system volume where source equipment requires a system minimum flow. Indicate valve control based on system flow meter value and system minimum flow setpoint.
   12. Specify 6-way valves to change over 2-pipe terminal equipment.
   13. Specify globe valves for steam and larger modulating hydronic valves only when exceeding the capacity of a ball valve.
   14. Specify butterfly valves for the following conditions:
      a. When exceeding the capacity of ball valves for large, non-modulating, 2-postion hydronic valves.
      b. When exceeding the capacity of a globe valve for large, modulating hydronic valves used with a heat transfer device.
      c. When exceeding the capacity of a ball valve or for modulating hydronic valves used for flow throttling not associated with heat transfer device.
      d. Select modulating butterfly with a range from closed to 50-60 degrees open with proportional non-spring return actuators.
      e. Request approval from the WU PM before specifying fail safe butterfly valves which require a remote battery/capacitor. Specify valve with a lug body.
   15. Actuator power
      a. Schedule power voltage for actuators as 24VAC.
      b. BAS contractor will provide 120V power supply if required due to voltage drop.
      c. Conform to BAS contractor’s determination of valve voltage requirements.

E. Control dampers and actuators
   1. For JCI sole source projects, schedule control dampers and actuators as a JCI product.
2. For non-JCI sole source projects, schedule actuators as a Belimo product and dampers by the manufacturers in Section 23 30 00 “HVAC Air Distribution.”
3. Specify aluminum airfoil blades with blade seals and end seals in dampers.
4. Locate dampers and actuators at locations that allow for access, maintenance, and replacement.
5. Schedule control dampers on the drawings and indicate size, blade type (parallel or opposed), actuator type, and fail-safe position.
6. Configure dampers and actuators such that one actuator control only one damper connected via damper end shaft. Do not utilize jack shafts or locate dampers in walls. Layout multi-section dampers to allow for actuator access and maintenance.
7. Specify actuator as follows:
   a. Terminal equipment: Proportional actuators without spring return
   b. Indoor AHU with unconditioned OA: Proportional actuators with spring return
   c. Indoor AHU without unconditioned OA: Proportional actuators without spring return
   d. Actuators for outdoor RTU air: Proportional actuators with spring return
   e. Specify spring return normal positions as follows:
      1) Outdoor air: Normally closed
      2) Return air: Normally open
8. Actuator power
   a. Schedule power voltage for actuators as 24VAC.
   b. BAS contractor will provide 120V power supply if required due to voltage drop.
   c. Conform to BAS contractor’s determination of valve voltage requirements.
F. Hydronic sensors
   1. Typical temperature sensor: JCI TE-6000 series, 1000 ohm nickel without transmitter
      a. Locate temperature sensors in thermowells.
      b. Indicate temperature sensor locations and BTU meter sensors locations on the flow diagrams.
   2. Typical differential pressure sensor: Setra model 230 wetted differential pressure sensor with 3-valve manifold
      a. Indicate sensor locations on the flow diagrams with service valve located at the connection to the piping. Typically, specify copper tubing to connect to sensor.
      b. WU prefers sensors 4’ AFF in mechanical rooms. For other conditions, locate sensors above an accessible ceiling in a common space or corridor (not an office, classrooms, lab, etc.).
   3. See Section 22 05 00 & 23 05 00 “Common Work Results for Plumbing and HVAC” for flow meters.
G. Airside sensors
   1. Typical temperature sensor: JCI TE-6000 series, 1000 ohm nickel without transmitter
      a. Specify single point sensors for duct applications.
      b. Specify flexible averaging sensors for coil leaving air temperature applications.
      c. Indicate sensor locations on the flow diagrams.
   2. Typical differential pressure sensors: Setra model 264
      a. Indicate the pressure sensor locations on the airflow diagrams and the floor plans.
      b. Indicate the outdoor reference device and shall be coordinate location with the architect.
      c. Typically, specify a single building reference located on the roof with a vertical 1/2” copper riser used as a reference on each floor.
   3. Specify humidity sensors sparingly. Review specific conditions with the WU PM.
   4. Do not specify carbon dioxide sensors in excess of ASHRAE requirements.
H. Airflow measurement
   1. WU prefers differential pressure sensors for control sequences in lieu of airflow measurement.
   2. Specify airflow measurement sensors sparingly. Review specific conditions with the WU PM.
3. Do not detail airflow measurement sensors in unfiltered outdoor air.
4. Where approved, specify vortex shedding or thermal dispersion type sensors. Do not specify pitot tube type sensors.
5. Design for easy maintenance access and verify upstream and downstream straight duct requirements when selecting location.

I. Thermostats
1. Indicate a backbox and conduit rough-in for thermostat installations.
2. Indicate thermostat type number on the drawings.
3. Typical thermostat types and applications:

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Typical Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Sensor only, without a display,</td>
<td>Corridors, restrooms, classrooms greater than</td>
</tr>
<tr>
<td></td>
<td>without warm/cool adjust</td>
<td>1000 SF, auditoriums</td>
</tr>
<tr>
<td>T2</td>
<td>Without display, with a warm/cool adjust</td>
<td>Offices, conference rooms, classrooms less than</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1000 SF</td>
</tr>
<tr>
<td>T3</td>
<td>With display</td>
<td>Per WU request</td>
</tr>
<tr>
<td>T4</td>
<td>Viconics VT-8350</td>
<td>Residence halls</td>
</tr>
<tr>
<td>S1</td>
<td>Sensor only, with flush stainless steel wall plate</td>
<td>Gyms or other high abuse locations</td>
</tr>
</tbody>
</table>

J. Refrigerant monitors
1. See Part 2 for requirements.
2. Specify a hardwired interlock connecting the refrigerant monitor to the exhaust fan operation and makeup air.
3. Indicate on the drawings the control panel location, sensor locations, and remote horn/strobe to plan for required wall space.
4. Indicate a dedicated 20A 120V circuit.

K. Leak detection
1. Indicate a leak detection monitor at the lowest level of the building in a wet mechanical room or other unoccupied space.

L. Hardwired safeties
1. Specify hardwired safeties for life safety and equipment protection.
2. Typical applications: Refrigerant exhaust, freeze stat, high pressure safety, low pressure safety, etc.
3. Specify freeze stats in any unit with an OA connection. Locate upstream from cooling coil and downstream from preheat coil (when so equipped).

M. Sequences of operation
1. WU maintains standard sequences for common applications due to campus size.
2. Utilize WU standard sequences and WU blocks of standard routines.
3. Review with WU PM special applications which require non-standard sequences.

N. Interface with fire alarm system
1. Coordinate with electrical consultant to indicate a relay module at each AHU control panel for DDC interlock to fire alarm mode.
2. At smoke dampers and fire/smoke dampers, indicate DDC relay in series with fire alarm relay to close damper when system air is not flowing (i.e. AHU is off, in unoccupied mode, or other mode).

O. Electrical devices and relays
1. WU utilizes the following components on projects:
a. Functional Devices RIB relays with hand-off-auto switch
b. Ice cube relays with indicator light
c. Multifunction digital type time delay relays
d. Current transformers

P. Raceways
1. See section 26 05 00 “Common Work Results for Electrical” to determine raceway type.
2. In lieu of duplicating raceway requirements in Consultant’s Division 25 specification, refer Contractor to follow Consultant’s Division 26 raceway based on section 26 05 00 “Common Work Results for Electrical”
3. Where raceway requires high level of coordination for complex routing or architectural coordination, coordinate with electrical consultant to show spare conduit for temperature control contractor’s use.
4. WU accepts BAS control wiring in open J-hooks except for the following locations:
   a. Above 8’ AFF in unfinished spaces (closets, mechanical rooms, electrical rooms)
   b. Above acoustical ceilings

Q. Integration
1. Specify BACnet MS/TP integration in lieu of BACnet IP Integration for 3rd party devices to minimize data drops.

PART 2 PROVIDERS & PRODUCTS

2.1 SOLE SOURCE BAS PROVIDER

A. Johnson Controls Inc. – St. Louis Office
   314-569-1570
   www.johnsoncontrols.com
   Lou Nagy (Account Representative): louis.j.nagy@jci.com
   Brian Talbot (Lead Systems Specialist): brian.g.talbot@jci.com

2.2 MANUFACTURERS

A. Specify products from the following manufacturers based on local representation and support.
   1. BAS controls: JCI

PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS

A. Include the following text in the appropriate section of the project specifications:
   1. Contractor coordination drawings shall include BAS panel locations, sleeves required in concrete or masonry walls, and roof penetrations.
   2. Contractor shall test and adjust set point for electronic flow switches for chiller minimum flow rates or value indicated by Engineer.
COMMON WORK RESULTS FOR ELECTRICAL

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Medium voltage cables
   2. Low voltage cables
   3. Grounding and bonding for electrical systems
   4. Hangers and supports for electrical systems
   5. Conduit for electrical systems
   6. Boxes for electrical systems
   7. Cable trays for electrical systems
   8. Sleeves and sleeve seals for electrical raceway for cabling
   9. Vibration and seismic controls for electrical systems
  10. Identification for electrical systems
  11. Power system studies for electrical systems
  12. Wiring connections
  13. Lighting
  14. Lighting controls

B. Related sections
   1. Section 03 00 00 “Concrete”
   2. Section 26 20 00 “Low Voltage Electrical Distribution”
   3. Section 26 30 00 “Medium Voltage Electrical Distribution”
   4. Section 33 00 00 “Campus Utility Services”
   5. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Specify medium voltage cables as follows:
   1. Cable type: MV-105
   2. Conductor: Copper
   3. Conductor stranding: Compact round, concentric lay, Class B
   4. Conductor insulation: Ethylene-propylene rubber complying with AEIC CS8
   5. Voltage rating: 5/8 KV
   6. Insulation thickness: 133% insulation level
   7. Shielding: Copper tape, helically applied with 25% minimum overlap over semi-conducting insulation shield
   8. Cable jacket: Sunlight-resistant PVC
9. Maximum bending radius: 12x the cable diameter, including shipping reels, pulling operations, junction boxes, and terminations

B. Specify low voltage cables as follows:
   1. Conductor
      a. Solid copper for 10 AWG and smaller
      b. Stranded copper for 8 AWG and larger
      c. Do not specify aluminum conductors.
   2. Other
      a. Indoor/outdoor: Wiring in raceway with THHN, THWN, or XHHW insulation.
      b. Exterior underground: Wiring in raceway with RHH-2, RHW-2, or USE-2 insulation
      c. Metal Clad (MC) cable:
         1) Do not specify or allow MC cable for feeders, homeruns, inaccessible locations, installation in masonry walls, or where exposed to view in finished spaces.
         2) Allow MC cable for routing from receptacle to receptacle through stud walls and through the ceiling space for the final portion of branch circuit wiring between receptacles in adjacent walls of the same room or area.
         3) Specify 30’ maximum accumulated length of MC from device to conduit homerun.
      d. Do not specify Type BX/AC cable.

C. Grounding and bonding
   1. Specify connection of the system grounding electrode conductor to the neutral bar inside the transformer.
   2. Specify a continuous green insulated grounding conductor for the equipment grounding system. Do not specify or allow the raceway to serve as a ground.
   3. When transformers provide a separately derived system, specify the connection of the grounding electrode conductor to the neutral bar inside the transformer.
   4. Specify a wall mounted copper grounding bar with insulated mounting bushings as the grounding termination point of the service entrance and system bonding.
   5. Specify grounding electrodes as three ground rods located exterior to the building in close proximity to the electrical room. Coordinate to avoid other utilities.
   6. Indicate on the drawings the grounding bar, grounding electrode conductor, grounding electrodes, and all bonding of other systems.
   7. Specify a compression or exothermic welded system. Do not specify mechanical connections.

D. Lightning protection
   1. Specify a UL listed lightning protection system for all Danforth campus and South 40 buildings.
   2. Consult with WU PM for off campus buildings.

E. Hangers and supports
   1. Indoor, dry locations with steel conduit material: Specify electroplated or other standard protective coating. Bare, uncoated steel is not acceptable.
   2. Exterior locations or other areas with increased corrosion risk: Specify hot dipped galvanized, aluminum, or stainless steel supports and hangers. Analyze the entire system for galvanic corrosion and detail all required isolation of mixed metals.
   3. Where floor support stands are not on a housekeeping pad, specify a 1” minimum grout pad below the baseplate to minimize corrosion.

F. Equipment pads
   1. Specify a 4” minimum concrete housekeeping pad under floor mounted equipment.
2. Ensure pad size includes edge spacing for anchor bolts and seismic forces and that reinforcement complies with the ASHRAE Practical Guide to Seismic Restraint or was designed by a structural engineer.

G. Conduit for medium voltage electrical systems
1. Specify galvanized rigid steel (GRS) for interior conditions unless noted otherwise.
2. Specify aluminum rigid conduits (ARC) for exterior conditions, tunnels, parking garages, and other locations subject to corrosion.

H. Boxes for medium voltage electrical systems
1. Draw to scale the conduit bending radius and pull box sizes.
2. Include on the drawings an elevation/section view of the conduits entering the building and design the entrance pull box to accommodate cable bending radius based on the geometry.
3. Specify box material to match conduit material.

I. Conduit for low voltage electrical systems
1. Do not specify or permit conduit in any slab or below slabs on grade.
2. Specify EMT for typical interior conditions, except where prohibited by the NEC.
3. Specify aluminum rigid conduit (ARC) for exterior above grade conditions.
4. Specify direct buried Schedule 40 PVC conduit with polymer hand holes for below grade exterior conditions.
5. Specify flexible liquid-tight metal conduit (FLMC) for connections to HVAC equipment, in mechanical rooms, and exterior, damp, or wet locations.
6. Specify flexible metal conduit (FMC) for transformers and uninterruptible power systems.
7. Indicate on the drawings conduit routing for 2" conduit and larger.
8. Indicate on the drawings all miscellaneous conduit (e.g., card readers, exterior lights) routing from interior to exterior. Locate miscellaneous conduit penetrations in unfinished spaces or above accessible ceilings.

J. Boxes for electrical systems
1. Specify cast boxes in conjunction with galvanized rigid steel (GRS) or aluminum rigid conduit (ARC).

K. Cable trays for electrical systems
1. Do not specify cable tray for typical building electrical distribution.

L. Sleeves and sleeve seals for electrical raceway for cabling.
1. Coordinate with structural engineer and indicate on drawings all required sleeves, holes, block outs, etc. Where applicable, identify insulation, firestop, mechanical rubber seal sizes, and overall hole size on construction drawings.
2. Specify a water stop ring and a mechanical rubber seal in accordance with manufacturers’ requirements at holes through foundation walls.
3. Size holes through internal walls for conduit and firestopping, where required, in accordance with manufacturers’ requirements for annular space.
4. Specify sleeves as follows:
   b. Masonry partition wall: Specify shop fabricated, 20-gauge sheet metal and tuckpointing by mason.
   c. Existing non-structural wall: Not required. Specify core drill or neat sawcut. Verify with a structural engineer the wall is non-load bearing.
   d. Existing structural wall: Consult with a structural engineer for structural requirements.
   e. Floors, general dry locations: Not required. Specify a block-out for new construction or reinforcement scan and core drill for existing construction.
f. Floors, wet locations and mechanical rooms: Specify Schedule 40 galvanized steel pipe, 2” minimum above the finished floor. Specify a concrete curb in areas with multiple penetrations.

5. Vibration Isolation
   a. Vibration isolation of transformers, generators, or rotating equipment shall be coordinated with Acoustic Consultant. Electrical consultant to review Acoustic Consultant recommendations with WU PM at milestone reviews. On occasion Acoustic Consultant recommendations have been very conservative and non-typical for WUSTL and are not transparent to WUSTL until observed during construction.

M. Seismic
   1. For renovation projects without a geotech report, review Appendix for seismic site classification.

N. Identification for electrical systems
   1. Consult with WU PM for Asset Management tag requirements and specify accordingly.
   2. Identify equipment using an alpha numeric name from the table below.
      a. The alpha part is the equipment abbreviation.
      b. The numeric part shall be 3 digits. Note special cases for the first digit.
   3. When adding equipment within an existing building, use the same numbering scheme as the existing building and use the next number in the equipment series. Typically, equipment number XYZ-001 already exists. Coordinate with the WU PM.
   4. Specify appropriately sized nameplates permanently attached to major equipment items (i.e. transformers, panel boards, starters, variable speed drives, lighting inverters, generators, automatic transfer switches, etc.).
   5. Specify interior equipment nameplates as follows:
      a. 1/16” thick, two-ply, black, acrylic plastic
      b. 2-1/2” x 1” minimum size for equipment face area less than 16 SF and 4” x 2” minimum size for equipment face area greater than 16 SF
      c. 1/2” tall minimum white characters
      d. Zink plated steel rivets. Adhesive or screws are not acceptable.
      e. Tag size shall be appropriate for equipment name
   6. Specify exterior equipment nameplates as follows:
      a. 0.032” thick, engraved stainless-steel plates
      b. 4” x 1-1/2” minimum size
      c. 1/2” tall minimum black enamel filled characters
      d. Stainless-steel rivets. Adhesive and screws are not acceptable.
7. Specify naming according to the following legend:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Drawing ID</th>
<th>BAS ID (if different)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformers</td>
<td>T</td>
<td></td>
</tr>
<tr>
<td>Main Panel</td>
<td>MPH or MPL</td>
<td></td>
</tr>
<tr>
<td>Distribution Panel</td>
<td>X-DPH-Y or X-DPL-Y (see below)</td>
<td></td>
</tr>
<tr>
<td>Lighting Panel Boards</td>
<td>see below</td>
<td></td>
</tr>
<tr>
<td>Motor Control Center</td>
<td>MCC</td>
<td></td>
</tr>
<tr>
<td>Standby Generators</td>
<td>GEN</td>
<td></td>
</tr>
<tr>
<td>Automatic Transfer Switch</td>
<td>ATS</td>
<td></td>
</tr>
<tr>
<td>Uninterruptible Power Supply</td>
<td>UPS</td>
<td></td>
</tr>
<tr>
<td>Unit Substation</td>
<td>SUB</td>
<td></td>
</tr>
<tr>
<td>Pad Mounted Switch</td>
<td>PMS</td>
<td></td>
</tr>
<tr>
<td>Pad Mounted Transformer</td>
<td>PMT</td>
<td></td>
</tr>
<tr>
<td>Inverter</td>
<td>INV</td>
<td></td>
</tr>
</tbody>
</table>

8. Name lighting and appliance panel boards as follows regardless of what loads they serve:
   a. Designate 480V panel as “HP.”
   b. Designate panels below 480V as “LP.”
   c. Buildings with generators
      1) Designate panels with emergency/life safety loads as “EHP” or “ELP.”
      2) Designate panels with non-life safety loads as “SHP” or “SLP.”
      3) Designate panels not connected to the stand-by generator as “NHP” or “NLP.”
   d. In buildings with large distribution systems, consider adding a floor prefix number before the panel designation (e.g., “1-HP-2” for level 1, 480V, second panel on the floor). Utilize a 0 prefix for lower levels and basements.

9. Specify labeling for starters, disconnects, and VFDs which includes a description, equipment designation, and power source (e.g., “CONDENSER WATER PUMP CP-1, FED FROM DP-2”).

10. Specify 5kV loop switch labels as follows:
    a. A 6” x 2” label for each switch with white letters on a red background that reads: “WARNING SWITCH MAY BE ENERGIZED BY BACKFEED”
    b. A 6” x 1-1/4” label with white letters on a black background which identifies the loop name on the first line and the next building served on the second line. Request loop names from the WU PM. Example:

    LOOP X TO BUILDING A
    LOOP X TO BUILDING B

11. Specify labeling for load switches which includes description and equipment designation (e.g., “EAST WING TRANSFORMER T-1”).

12. Specify 6” wide x 0.035” metallic detection tape installed 12” above the conduit/duct bank with color and lettering according to the following legend:

<table>
<thead>
<tr>
<th>Service</th>
<th>Color</th>
<th>Legend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric 4160V</td>
<td>Red</td>
<td>Caution Buried High Voltage Electric</td>
</tr>
<tr>
<td>Electric</td>
<td>Red</td>
<td>Caution Buried Electric</td>
</tr>
<tr>
<td>Fiber Optic</td>
<td>Orange</td>
<td>Caution Buried Fiber Optic</td>
</tr>
<tr>
<td>Telephone</td>
<td>Orange</td>
<td>Caution Buried Communication</td>
</tr>
<tr>
<td>CATV</td>
<td>Orange</td>
<td>Caution Buried CATV</td>
</tr>
</tbody>
</table>
O. Power system studies for electrical systems
   1. Begin coordination studies, short circuit studies, and arc flash studies as follows:
      a. New Danforth buildings: Begin at the local 5kV loop switch.
      b. Existing Danforth buildings: Request existing information from WU PM.
      c. Off campus buildings: Begin at Ameren transformer. Request point of connection values from
         the WU PM.
   2. Perform preliminary coordination studies, short circuit, and arc flash studies at the start of the CD
      phase with the following objectives:
      a. To affect the design to minimize arc flash
      b. To allow scheduling equipment short circuit ratings for bidding
      c. To allow scheduling circuit breakers that require LSI modules for bidding

P. Wiring connections
   1. Specify wire nutted connections for 10 AWG and smaller.
   2. Specify insulated multiple tap connectors for 8 AWG and larger.
   3. Do not specify push-in wire connectors.

Q. Lighting
   1. Interior lighting
      a. Specify only LED lighting.
      b. Specify 2’ or 4’ fixtures. Do not specify 3’, 6’, 8’ or other atypical fixture sizes.
      c. Specify a recessed can housing and screw-in LED bulb. Do not specify integrated LED downlights.
      d. Minimize fixture types to simplify ongoing maintenance and replacement for WU.
      e. Specify 3500K color temperature.
      f. Include a lighting schedule on the drawings with a 1”x1” (approx.) image of the fixture.
      g. Include cut sheets and list prices for all light fixtures in the specifications.
   2. Exterior lighting
      a. Specify 4000K color temperature for garages and surface parking lots.
      b. Danforth Campus
         1) Specify 3000K color temperature for pedestrian pathways and building lighting.
         2) Pole: Stresscrete KS14-E60-G-DB
         3) Luminaire: King 118R
      c. South 40
         1) Specify 3000K color temperature for building lighting.
         2) Specify 4000K color temperature for pedestrian pathways.
         3) AAL PRM3-T3 drawings number “17A-1187”

R. Lighting controls
   1. Specify a controls package utilizing the manufacturer identified in Part 2 unless noted otherwise.
   2. Engage the lighting controls representative as a design-assist partner during the design process and
      milestone reviews.
   3. Renovations less than 500 SF or 3 or fewer contiguous offices do not require lighting controls unless
      the building has an existing lighting controls system.
   4. Strive for 95% or greater implementation of factory integrated sensors.
   5. Specify the appropriate equipment and support to interface controls with BAS system via BACnet.

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

   A. Coordination drawings
      1. Require and review service clearances and seismic supports on the coordination drawings.
B. Closeout submittals
   1. Require in the closeout documents a letter from the seismic engineer stating that the completed installation meets the design intent.

PART 2 PROVIDERS & PRODUCTS

2.1 SOLE SOURCE PROVIDERS
   A. Enlighted Controls (www.enlightedinc.com)
      Lighting Associates (manufacturer’s representative)
      314-534-3500
      www.laiweb.net
      Bruce McCoy (bmmcoy@laiweb.net)

2.2 MANUFACTURERS
   A. Specify products from the following manufacturers based on local representation and support. Submit other manufacturers with local representation and support to the WU PM for approval.
      1. Medium voltage cables: Okonite Company, Prysmian Group, Southwire Company
      2. Medium voltage splices and terminations: 3M Company, Raychem Corporation
      3. Medium voltage separable connectors: Thomas & Betts/Elastimold, Cooper Power Systems
      4. Labels and nameplates: Seton, Brady Worldwide Inc, Craftmark, Brimar Industries
      5. Lighting: Cooper, Eaton, Focal Pointe, GE, Lithonia, Metalux, Philips, Sylvania
      6. Lighting controls: Enlighted (no substitutions)

PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS
   A. Include the following text in the appropriate section of the project specifications:
      1. Contractor shall submit a listing of all equipment to be labeled with the proposed content for each label.
      2. Contractor shall not install conduit in the slab or below slabs on grade unless specifically designed and detailed that way on the drawings.
      3. Contractor shall only use those seismic materials submitted and approved. Contractor shall notify Seismic Engineer when actual installation differs from the approved Seismic shop drawing.
      4. Contractor shall not include prefabricated conduit/support assemblies in base bid price but shall include cost savings as a voluntary alternate. Where prefabricated conduit/support assemblies are allowed by Owner, the details and savings shall be negotiated separately post bid. Contractor shall ensure there is adequate room for trapeze hangers that may not have been accounted for in the design. Contractor shall remove longitudinal braces between pipe supports after installation.
      5. Contractor shall not include prefabricated equipment skids in base bid price but shall include cost savings as a voluntary alternate. Where contractor fabricated skids are allowed by Owner, the details and savings shall be negotiated separately post bid. Skids shall be hot dipped galvanized or constructed of non-ferrous materials for long term corrosion resistance. Contractor shall submit skid shop drawings for approval.
6. Contractor shall not use metal or wood roof decks for supporting the conduit or equipment. Power driven inserts and attachments are not permitted.

7. Contractor shall clearly identify on electrical shop drawings the areas that cast in place inserts are required. Identify a detailed layout on the shop drawings if required.

8. Contractor shall maintain the larger of the two minimum cable bending radius required by the NEC and the cable manufacturer at all times during the installation. Bending cables to less than the minimum radius shall be reason to reject the cable.

9. Contractor shall notify Owner’s Representative to witness 5kV pulling setup and sheeves prior to cable installation.

10. Contractor shall submit 5 kV pulling tension data logger history or use a cable puller that does not exceed the cable allowable pull tension as agreed to and witnessed by Owner’s Representative.

11. Contractor shall notify Owner’s Representative to witness grounding.

12. Contractor shall indicate on record drawings the location and wire routing of the grounding electrode conductor, grounding electrodes, and all bonding of other systems.

13. Contractor shall test phasing of 5kV cables at loop switches prior to closing the switch and shall test each time the switch is to be closed. Coordinate testing so that Owner’s Representative is present. Correct phasing as required to match existing phasing and rotation. At the completion of the project the loop switch shall be closed.

14. When connecting new 5kV cable to existing 5kV cable, Contractor shall test the new cable via DC High Potential Test limited to 25,00 volts prior to connecting to the existing cable. After the final connections are made, the Contractor shall test both the new and the existing cable with a Megohm meter at 5,000 volts.

15. Include in Project Specifications: 600V wire shall be color coded up to 750 mcm. Taping phase colors is not permitted.

16. Contractor shall not overpour duct banks beyond 6” from design dimension.

17. Contractor shall not combine power and telecommunication duct banks into a common non-separated pour.
PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Medium voltage transformer
   2. Medium voltage switchgear
   3. Medium voltage circuit protect devices

B. Related sections
   1. Section 26 05 00 “Common Work Results for Electrical”
   2. Section 26 20 00 “Low Voltage Electrical Distribution”
   3. Section 33 00 00 “Campus Utility Services”
   4. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. General
   1. Local electrical inspectors strictly enforce the UL requirements of the NEC. Specify equipment, devices, and fabricated control panels which are UL listed as a complete assembly.
   2. Maintain electrical equipment room environmental conditions between 50°F - 90°F 24/7/365. Specify filtered outdoor air for cooling or ventilation. Coordinate the locations and load of heat producing electrical equipment with mechanical consultant.
   3. The campus utility engineer sizes the building transformer using more diversity than provided with NEC capacity calculations.
   4. Show required electrical clearances in front of each panel on the construction documents.

B. Programming considerations
   1. WU prefers a dedicated electrical room to contain the electrical service. Locate the room to maximize conduit access in and out of the space. Do not limit access by the building architecture (i.e. do not locate under the building lobby, auditorium, etc.).
   2. Do not allow other utilities (i.e. ductwork and piping) in the electrical room unless they serve the electrical room.
   3. If the main electrical room is on the lower level, elevate the entire room as follows:
      a. 24” height for lower level floor size below 20,000 SF
      b. 18” height for lower level floor size above 20,000 SF
      c. Include stairs and landings during programming.
   4. Identify a pathway and provide structural support along the pathway for the replacement of transformers and other large equipment.

C. Medium voltage dry transformers
1. Specify transformers with a 4160 V delta primary and 480Y/277 or 208Y/120 secondary.
2. Specify transformers with multiple taps for 2.5% full current below normal and 2.5% full current above normal.
3. Aluminum windings are acceptable.
4. Specify 3.5% minimum impedance.
5. Specify transformers as ANSI Class AA (self-cooled) as defined by ANSI-C57.12.01.
6. Specify transformers as 115°C temperature rise above 40°C ambient.
7. Specify 55°C rise transformers capable of carrying a 15% continuous overload without exceeding a 55°C rise in a 40°C ambient.

D. Medium voltage oil filled pad mounted transformers
1. Specify transformers with a 4160 V delta primary and 480Y/277 or 208Y/120 secondary.
2. Specify transformers with multiple taps for 2.5% full current below normal and 2.5% full current above normal with hot-stick operated tap changers.
3. Aluminum windings are acceptable.
4. Specify dead front design.
5. Specify three sets of independent 2 position, 3 pole, internal oil immersed load break switches:
   a. Specify two sets as 400A minimum of incoming loop without key interlocks and one transformer switch.
   b. Specify switching does not cause a momentary de-energizing of the transformer.
   c. ‘V’ and ‘T’ blade switching is not acceptable.
6. Specify secondary fusing as Three Bay-o-net oil immersed in series with ELS-P current limiting type fuses with 50,000A interrupting capacity.
7. Specify high-voltage terminations as six dead-break 600A separable pin connectors with six parking stands and six insulated parking bushings.
8. Specify low voltage terminations as tinned spade type with ANSI bolt tappings.
9. Specify the surge arrestor in the transformer oil tank.
10. Specify the following options:
    a. Oil drain valve
    b. Separate oil sampler device
    c. Dial type thermometer mounted in a well with resettable high temperature slave hand indicator
    d. Oil filling fitting
    e. Liquid level gauge
    f. Self-actuating pressure release device to vent pressure at 10 psig
    g. Vacuum/pressure gauge with a range of –10 psig vacuum to +10 psig pressure
11. Specify installation on a 16” thick minimum concrete pad, 8” below grade and 8” above grade. Do not locate transformer on top of a manhole or vault.
12. Provide adequate working clearance, including 10’ hot stick operation.
13. Locate high voltage and low voltage conduits to the respective sections.

E. Medium voltage switchgear
1. Metal enclosed switchgear
   a. Specify for indoor loop switches on the Danforth Campus and South 40.
   b. Specify 600A buss and switches.
   c. Specify 25 kA symmetrical short circuit.
   d. Specify incoming non-fused duplex switch without key interlock.
   e. Specify fused load switches.
   f. Specify transition section between incoming and load switches. Inverted switches are not acceptable.
   g. Specify bus runbacks for rear connections for each switch.
h. Specify full barriers switch to switch and front to rear.

2. Metal clad switchgear
   a. Specify vacuum circuit breakers immediately downstream of the utility feed to campus.
   b. Do not specify for building connections to the campus loop.

3. Pad mounted switchgear
   a. Specify for outdoor loop switches on the Danforth Campus and South 40.
   b. Specify 600A buss and switches.
   c. Specify 25 kA symmetrical short circuit.
   d. Specify non-fused incoming switches.
   e. Specify fused load switches.
   f. Specify S&C configuration PMH-9 as the typical configuration.
   g. Specify installation on a 16” thick minimum concrete pad, 8” below grade and 8” above grade.
      Do not locate transformer on top of a manhole or vault.
   h. Provide adequate working clearance, including 10’ hot stick operation.
   i. Locate high-voltage and low-voltage conduits to the respective sections

F. Medium voltage circuit protect devices
   1. Medium voltage fuses
      a. Specify fuses for transformers as current limiting E rated.
      b. Specify fuses for motor loads as current limiting R rated.
      c. Specify fuses for campus loop distribution feeders as 400E boric acid expulsion type unless instructed otherwise.
   2. Medium voltage lightning arrestors
      a. The campus electrical distribution is underground. Specify lightning arrestors on above ground outdoor medium-voltage equipment only.

PART 2 PROVIDERS & PRODUCTS

2.1 MANUFACTURERS

   A. Specify products from the following manufacturers based on local representation and support. Submit other manufacturers with local representation and support to the WU PM for approval.
   1. Transformers and switchgear: ABB, Eaton, General Electric, Siemens, Square D
   2. Fuses: Eaton-Bussmann, Mersen

PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS

   A. Include the following text in the appropriate section of the project specifications:
   1. Contractor coordination drawings shall utilize approved equipment shop drawings.
   2. Contractor shall provide medium voltage fuses from only one manufacturer. Contractor shall furnish and install spare fuse cabinet and provide three spare fuses for each type and size used.
   3. Contractor shall verify existing systems for sizes, capacity, materials, and elevations before installing new work which ties into existing systems. Contractor shall notify Architect/Engineer upon discovery of any discrepancy. Contractor shall correct work performed prior to verification at no cost to Owner.
4. Contractor shall provide temporary labels for all switches and circuit breakers using painter’s tape and permanent marker and maintain pencil copies of panel board directories during construction and until permanent labels and panel directories.
26 20 00

LOW VOLTAGE ELECTRICAL DISTRIBUTION

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Low voltage transformer
   2. Low voltage switchgear
   3. Switchboards
   4. Panelboards
   5. Electricity metering
   6. Low voltage distribution equipment
   7. Low voltage circuit protect devices
   8. Low voltage controllers

B. Related Sections
   1. Section 26 05 00 “Common Work Results for Electrical”
   2. Section 26 10 00 “Medium Voltage Electrical Distribution”
   3. Section 33 00 00 “Campus Utility Services”
   4. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. General
   1. Local electrical inspectors strictly enforce the UL requirements of the NEC. Specify equipment, devices, and fabricated control panels which are UL listed as a complete assembly.
   2. Maintain electrical equipment room environmental conditions between 50°F - 90°F 24/7/365. Specify filtered outdoor air for cooling or ventilation. Coordinate the locations and load of heat producing electrical equipment with mechanical consultant.
   3. Indicate required electrical clearances in front of each panel on the construction documents.
   4. Specify panels with spare capacity for both load and buss space.

B. Programming
   1. WU prefers a dedicated electrical room to contain the electrical service. Locate the room to maximize conduit access in and out of the space. Do not limit access by the building architecture (i.e. not located under the building lobby, auditorium, etc.).
   2. WU prefers stacked electrical rooms for floor by floor switchboards and panelboards.
   3. Do not allow other utilities (i.e. ductwork and piping) in the electrical room unless they serve the electrical room.
   4. Identify a pathway and provide structural support along the pathway for the replacement of transformers and other large equipment.
5. Coordinate with mechanical, plumbing, and fire protection consultants to show electrical panels and motor controllers for coordination and allocation of wall space.

C. Low voltage distribution transformers
   1. Specify typical, low-voltage distribution dry type transformers with a 480 delta primary and 208Y/120 secondary.
   2. Specify transformers with 2.5% full current below normal taps and 2.5% full current above normal taps.
   3. Aluminum windings are acceptable.
   4. Specify transformers as ANSI Class AA (self-cooled) as defined by ANSI-C57.12.01.
   5. Specify transformer as 115°C temperature rise above 40°C ambient.
   6. Specify 115°C rise transformers capable of carrying a 15% continuous overload without exceeding a 150°C rise in a 40°C ambient.
   7. Specify minimum impedance of 5.75%.

D. Low voltage switchgear (ANSI C37.13, UL 1558, 60” deep, requires rear access)
   1. WU does not typically use low voltage switchgear in the building distribution system.
   2. WU occasionally uses low voltage switchgear for applications requiring the highest levels of redundancy and reliability.
   3. Specify rail mounted lifting device.

E. Switchboards (UL 891, NEMA PB-2, 1600-5000A, <36” deep) and Distribution Panelboards (UL 67, NEMA PB-1, 400-1200A, <12” deep)
   1. Do not specify switchboards that require rear access.
   2. Specify multi-section switchboards with 100% horizontal and vertical bussing.
   3. Specify plated copper bus and ground.
   4. Fusible switches
      a. Specify Class R fuses for switches 600A and below.
      b. Specify Class L fuses for switches 800A and above.
      c. WU accepts high pressure contact switches. Bolted pressure switches and Pringle switches are not acceptable.
      d. Specify twin mounted switches for switches 200A and below.
   5. Circuit breakers
      a. Specify molded case circuit breakers. Do not specify draw-out breakers unless specifically requested by WU.
      b. Specify adjustable LSI trip modules where needed for coordination or lowering arc flash and on breakers 600A and larger.
      c. Specify arc flash maintenance mode switch on building main circuit breaker(s).

F. Panelboards – Lighting and Appliance (per UL 67, NEMA PB-1, 400A and below)
   1. Specify surface mounted panelboards. Do not specify recessed panels in walls due to the difficulty of adding future circuits and damage to the finishes from removing the cover. Coordinate with Architect if a shallow closet is required.
   2. Feed through lugs are permissible for two section panels only.
   3. Specify panels to have a main circuit breaker.
   4. Specify a single feeder with multi-tap insulated lugs to feed a panel with a main circuit breaker equal to the feeder overcurrent device where dedicated feeders are not cost effective or required for the load. This design allows greater flexibility in maintenance and future replacement than a feed through panel design.
   5. Specify plated copper bus and ground.
7. Specify panels 225A and less to be full of spare breakers in lieu of spare space.
8. Specify door in a door hinged trim when available.

G. Motor control centers
1. Do not specify motor control centers. In lieu of a motor control center, feed loads from a panelboard with local motor controllers located near the equipment.

H. Low voltage distribution equipment
1. Wiring devices
   a. Specify high quality devices, similar to Hubbell 5362 20A duplex receptacles and Hubbell 1221 20A switches.
   b. Specify nylon cover plates.
   c. Clearly identify on the drawings and specifications device and cover plate colors.
   d. Specify colors per the following matrix and confirm with architect and WU PM.

<table>
<thead>
<tr>
<th>Description/location</th>
<th>Device color</th>
<th>Cover plate color</th>
</tr>
</thead>
<tbody>
<tr>
<td>White walls</td>
<td>White</td>
<td>White</td>
</tr>
<tr>
<td>Dark woodwork</td>
<td>Black</td>
<td>Black</td>
</tr>
<tr>
<td>Light woodwork</td>
<td>Ivory</td>
<td>Ivory</td>
</tr>
<tr>
<td>Labs</td>
<td>Gray</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Stages</td>
<td>Black</td>
<td>Black</td>
</tr>
<tr>
<td>Emergency</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Isolated ground</td>
<td>Orange</td>
<td>Orange</td>
</tr>
</tbody>
</table>

I. Electric metering
1. Specify meters as OFCI. See Part 2 for manufacturer information.
2. For bidding clarity, specify switchboards that require metering as meter ready with CTs and shorting blocks.
3. Specify meters for main switchboard(s), load side of automatic transfer switches, and dedicated HVAC distribution panel boards for submetering.
4. Indicate on the drawings a meter riser diagram and schedule with meters numbered sequentially 1 to X. Indicate the building main meter as meter #1 and daisy chain all sub-meters per RS-485.
5. Coordinate with the communications consultant to indicate a data drop at the building main meter.

J. Low voltage circuit protect devices
1. Low voltage fuses
   a. Show on the drawings the location of the spare fuse cabinet.
2. Enclosed switches
   a. Specify switches with a quick make, quick break mechanism operating through the box and not the cover. Ensure switchblades are visible when the hinged door is open.
   b. Specify an auxiliary position switch when used on the load side of VFD and indicate for the switch to be wired to VFD safety circuit.
   c. Specify NEMA 4X rating for exterior locations.

K. Low voltage controllers
1. Specify all components to be NEMA rated. Do not specify or allow IEC rated components.
2. Fractional HP single phase manual starters
   a. Specify starters with toggle switch operation and lock-out guard, single thermal overload.
   b. Indicate on drawings whether starters have or do not have a pilot light.
   c. Specify an “FS” conduit box for all surface mounted starters.
3. Single phase magnetic starters
a. Specify starters with one overload, 120V coil, N.O. auxiliary contacts, heavy-duty 30 mm and hand off automatic selector switch in cover, all in an oversized NEMA enclosure.

4. Three phase manual starters
   a. Specify starters with push button operation, lock-out guard, and three thermal overloads in a NEMA enclosure.
   b. Indicate on drawing whether starters have or do not have a pilot and/or auxiliary contacts.

5. Three phase magnetic starters
   a. Specify with three overloads, 120V control transformer with 2 primary fuses and 1 secondary fuse, heavy-duty 30 mm, hand off automatic selector switch, heavy-duty 30 mm pilot light, and extra N.O. auxiliary contacts, all in a NEMA enclosure.

6. Three phase combination starter and fusible disconnect switch
   a. Specify three pole fusible switch and a starter with three overloads, 120V control transformer with 2 primary fuses and 1 secondary fuse, heavy-duty 30 mm, hand off automatic selector switch and heavy-duty 30 mm pilot light and N.O. auxiliary contacts.

7. Variable frequency motor drives/controllers (VFDs)
   a. Specify products per Part 2.
   b. Specify an inductive absorber at the VFD per Par 2.
   c. Do not specify packaged equipment with drives that do not comply with part 2 products.
   d. Specify VFDs with a circuit breaker or input fuses, a minimum of 3% DC link or line reactor, and BACnet MS/TP communication card.
   e. Specify a three contactor bypass except at parallel pumps or applications with built in redundancy.

8. Elevator power controller
   a. Specify a fused switch with shunt trip per Part 2.
   b. Specify switches with a 120V control power transformer, fire safety interface relay with 120V coil, key test switch, green “on” pilot light, and shunt trip voltage monitoring relay.

PART 2 PROVIDERS & PRODUCTS

2.1 MANUFACTURERS

A. Specify products from the following manufacturers based on local representation and support. Submit other manufacturers with local representation and support to the WU PM for approval.

1. Transformers, switchgear, switchboards, panelboards, low-voltage circuit protect devices, and low-voltage controllers: ABB, Eaton, General Electric, Siemens, Square D
2. Variable frequency drives/controllers: ABB ACH 580 (preferably wide body) or Toshiba Q9+ (no substitutions)
3. Inductive absorber: CoolBLUE (no substitutions)
4. Meters (building): Square D PM5000 series (no substitutions)
5. Meters (submeters): Schneider Electric Entercept Meter or Energy Meter (no substitutions)
6. Wiring Devices: Hubbell, Leviton, Cooper, P&S
7. Fuses: Eaton-Bussmann “Low Peak” or Mersen “Amptrap 2000”
8. Elevator power controller: Bussmann Power Module Switch (or equivalent by Mersen or Eaton Cutler Hammer)
PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS

A. Include the following text in the appropriate section of the project specifications:

1. Contractor shall indicate and verify panel feeder orientation and indicate on shop drawings prior to submitting to Engineer.

2. Contractor shall provide fuses from only one manufacturer. Contractor shall furnish and install spare fuse cabinet and provide three spare fuses for each type and size used.

3. Contractor shall verify existing systems for sizes, capacity, materials, and elevations before installing new work which ties into existing systems. Contractor shall notify Architect/Engineer upon discovery of any discrepancy. Contractor shall correct work performed prior to verification at no cost to Owner.

4. Contractor shall provide temporary labels for all switches and circuit breakers using painter’s tape and permanent marker and maintain pencil copies of panel board directories during construction and until permanent labels and panel directories.

5. Contractor shall update panel directories with a new typed version if work modifies the panel directory.
FACILITY ELECTRICAL POWER GENERATING & STORAGE EQUIPMENT

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Photovoltaic collectors
   2. Packaged generator assemblies
   3. Lighting inverters
   4. Uninterruptible power supply
   5. Power conditioning units
   6. Transfer switches

B. Related sections
   1. Section 07 30 00 “Roofing”
   2. Section 26 05 00 “Common Work Results for Electrical”
   3. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. General
   1. Local electrical inspectors strictly enforce the UL requirements of the NEC. Specify equipment, devices, and fabricated control panels which are UL listed as a complete assembly.
   2. Discuss the need for an engine generator at the earliest stages of programming and design to incorporate the requirements in the architectural, mechanical, and electrical designs.
   3. Discuss code-required standby power requirements with the WU PM. Present alternate code compliance paths to WU for evaluation.
   4. Specify an uninterruptible power supply for all loads which cannot tolerate any power interruptions, including 15 second automatic switching operations.
   5. Specify engine generator backup for loads which cannot tolerate extended (24 hour) power outage, or loads required by Code.
   6. Power quality is that as supplied by the Utility Company. Specify a power conditioning unit for loads which require higher power quality.
   7. Identify a pathway and provide structural support along the pathway for installation and replacement of large equipment.
   8. Show the required electrical clearance for all equipment on the construction drawings.
   9. Maintain electrical equipment room environmental conditions between 50°F - 90°F 24/7/365. Specify filtered outdoor air for cooling or ventilation. Coordinate the locations and load of heat producing electrical equipment and batteries with mechanical consultant.

B. Photovoltaic systems
1. Typically, WU contracts with a third party solar EPC firm to design, procure, and install the PV system after substantial completion, whether through a lease or outright purchase.
2. Design all new buildings and gut renovations to be PV ready, including, but not limited to:
   a. (1) 2” minimum power conduit from the roof level to the electrical room
   b. (1) 1” minimum communication conduit from the roof level to the electrical room
   c. Solar interconnection point to the building electrical system, including inverter power factor
   d. Space allocation on walls for disconnects, internal inverters, or combiner panels
   e. Identify point of common coupling on the panel schedule and panel directory as “FUTURE SOLAR.”
   f. 10 PSF structural load allowance for ballasted PV systems
3. Where adequate fall protection is not present (42” high parapet or fully engineered fall protection system), assume 8’ minimum clear distance from edge of solar panels to edge of roof to allow for a 6’ hazard zone and 2’ walkway.
4. Where adequate fall protection is present, assume 4’ minimum clear distance from edge of solar panels to inside of parapet.
5. Locate PV disconnects on the Danforth and S40 campuses in the electrical room.
6. Locate PV disconnects on off-campus properties on the building exterior.

C. Diesel-Engine-Driven generator sets
1. Determine runtime on a per building basis.
2. Typical WU generators utilize a belly tank for fuel storage. Coordinate with project team during programming for refueling considerations.
3. Design a hot dipped galvanized access platform when tank is taller than 24”.
4. Diesel exhaust odor is highly detectable by building occupants. Carefully locate generator exhaust considering proximity to air intakes.
5. Evaluate the advantages of routing generator exhaust to mix with generator radiator discharge air flow for dilution in tandem with increased mixture travel distance.
6. Coordinate external exhaust systems and insulation with mechanical consultant.
7. Coordinate with the acoustical consultant to analyze generator sound and vibration impacts.
8. Confirm and specify the following typical accessories and options:
   a. NFPA-110 Level 1 microprocessor controller with required indicators, alarms, and shut-downs
   b. Common failure relay kit programmed to signal low fuel, auxiliary fault, emergency stop, high engine temperature, low oil pressure, overcrank, and overspeed.
   c. Remote emergency stop kit
   d. Remote annunciator panel
9. Specify BAS monitoring of general alarm and run status.
10. Specify factory startup and field load testing in accordance with NFPA 110.
11. Specify a remote fuel level indicator at remote filling station.
12. Specify five-year parts and labor warranty.

D. Lighting inverters
1. WU prefers decentralized lighting mini-inverters over centralized building wide systems.
2. Design mini-inverters to serve one floor maximum.
3. Specify sealed maintenance-free batteries.

E. Uninterruptible power supply (UPS)
1. Specify UPS at the lab or equipment level in lieu of a building system.
2. Specify an internal maintenance bypass to allow for service and repair.
3. Select UPS equipment with power conditioning and on-line power protection for critical electronic equipment loads.
4. Specify factory startup.
5. Specify 5 year parts and labor warranty.

F. Manual transfer switches
   1. Some projects may utilize manual transfer switches to provide connection of temporary generators for planned outages or extended unplanned outages for select loads only.
   2. Specify an electric meter on the load side of transfer switch per the applicable related Section.

G. Automatic transfer switches
   1. Specify a maintenance bypass to allow for service and repair.
   2. Design and specify front access only equipment.
   3. Specify closed transition type for most systems to allow monthly testing under load.
   4. Evaluate the ground current paths and locations of ground fault relays.
      a. Specify 3-pole ATS when generator is not a separately derived system.
      b. Specify 4-pole ATS when generator is a separately derived system.
      c. Specify generator systems which are all either 3-pole or all 4-pole. Do not combine systems.
   5. Specify an electric meter on the load side of transfer switch per the applicable related Section.
   6. Review ATS setting parameters prior to startup and provide recommended settings to WU PM.
   7. Specify factory startup.
   8. Specify a 5 year parts and labor warranty.

1.3 SUBMITTALS, QUALITY ASSURANCE, & LOGISTICS

A. Coordination drawings
   1. Ensure pad size is coordinated with approved equipment submittal, seismic snubber and anchor bolt requirements, pad reinforcing, pad chamfer strips, and pad doweling to floor.
   2. Ensure electrical rough-in size and location and final connection locations and quantities are coordinated with approved equipment submittal.

B. Specify pre-installation meetings for the following:
   1. Equipment pad installation
   2. Under slab plumbing around generators

PART 2 PROVIDERS & PRODUCTS

2.1 MANUFACTURERS

A. Specify products from the following manufacturers based on local representation and support. Submit other manufacturers with local representation and support to the WU PM for approval.
   1. Packaged generator assemblies: Caterpillar, Cummings, Kohler
   2. Lighting inverters: Eaton, Dual-Lite/Hubbell, Schneider Electric
   3. Mini-inverters: Bodine, Myers Power Products
   4. Uninterruptible power supply: APC, Liebert, Powerware-Eaton, Schneider Electric
   5. Transfer switches: Asco Power Technologies, Caterpillar, Cummings, Kohler

PART 3 EXECUTION – NOT USED
3.1 SPECIFICATION REQUIREMENTS

A. Include the following text in the appropriate section of the projection specifications:
   1. Contractor shall indicate and verify feeder orientation and indicate on shop drawings prior to submitting to Engineer.
   2. Contractor shall provide generator load bank and temporary cables for field testing. Owner will provide the fuel.
   3. During construction until permanent labels and panel directories are installed, all switches/circuit breakers Contractor shall provide temporary labels with painters tape and permanent marker and maintain pencil copies of panelboard directories.
   4. Contractor shall provide on-site training by factory authorized representative.
The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Electronic safety & security systems

B. Related sections
   1. Section 08 10 00 “Door and Frames”
   2. Section 08 40 00 “Entrances, Storefronts & Curtain Wall”
   3. Section 08 71 00 “Door Hardware”
   4. Section 32 00 00 “Exterior Improvements”
   5. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS

A. Coordination
   1. WU utilizes the sole source provider (SSP) listed in Part 2 for Electronic Safety & Security.
   2. The WU Access Control & Electronic Security Office (ACESO) operates WU’s electronic safety and security systems (CardAccess@wustl.edu).
   3. Review project security requirements with the ACESO, WU Police Department, WU PM, and SSP.
   4. Include the SSP on pertinent design team communication and collaborate with the SSP as a design-assist partner, including the following milestone based tasks:
      a. SD milestone review:
         1) Request typical door rough-in details with associated costs of SSP scope.
         2) Invite SSP to the architectural page-turn.
      b. DD milestone and 50% CD reviews:
         1) Coordinate with SSP to prepare DD level shop drawings for design team and WU review, including plans, access control door hardware coordination schedule, and product cut sheets.
         2) Confirm specific requirements for open pathway wiring or conduit raceways (including painting).
         3) Invite SSP to the architectural page-turn.
   5. Specify project walk-throughs with the WU PM, ACESO, and SSP to confirm rough-in locations and final locations of equipment, devices, alarms, etc.

B. Programming & design considerations
   1. ACESO requires a stand-alone equipment room incorporating the following minimum parameters:
      a. 7’ wide x 5’ deep to allow 36” minimum clear in front of racks and panels
      b. Out-swinging double doors on 7’ wall accessible from public corridor
c. Power and data rough-ins coordinated with requirements contained in this section and shown on project drawings:
   1) 4 horizontal feet of fire rated plywood for each group of 16 card readers
   2) 2 horizontal feet of fire rated plywood for any CCTV system
   3) 1 dedicated 20A circuit for each group of 16 card readers
   4) 1 dedicated 20A circuit for each CCTV rack
   5) 1 network drop for each group of 16 card readers
   6) 2 network drops for each CCTV rack
   7) 1 fire alarm relay in equipment room

d. Ventilation to accommodate security equipment heat generation

e. No plumbing or hydronic lines over the room

f. No cleanouts or access panels within the space.

2. Specify generator backed circuits for CCTV and Card Access systems.

3. Coordinate the vertical riser requirements for work performed by the SSP.

4. ACESO discourages the use of magnetic locks.

5. Cameras
   a. Coordinate an interior camera focused on door ingress at every perimeter door.

C. Construction procedures

1. The site electrician installs the electronic safety and security rough-ins. Indicate on the electrical and low voltage drawings all rough-in requirements. Typical rough-ins include:
   a. Vertical risers
   b. Door power and low voltage
   c. Camera power and low voltage

2. The SSP and their subcontractor pull wire, install devices, trim equipment, test systems, and train WU.

The products and information on the following pages are for reference only and typically do not require review, coordination, or selection by the Design Team.

PART 2 PROVIDERS & PRODUCTS

2.1 SOLE SOURCE ELECTRONIC SAFETY & SECURITY PROVIDER

A. PASS Systems
   314-241-0422
   www.passsecurity.com
   Kendall Addison (314-369-2661, kaddison@passsecurity.com)
## 2.2 PRODUCTS

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>ITEM</th>
<th>MANUFACTURER</th>
<th>MODEL</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Card Reader</td>
<td>Typical Card Reader</td>
<td>Mercury Security Corporation</td>
<td>MR5 Magnetic Swipe Reader</td>
<td>Color: Black</td>
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<tr>
<td></td>
<td>Alternate Wireless Card Reader (limited applications)</td>
<td>Schlage</td>
<td>Wireless AD400 Series</td>
<td>ACESO must approve any alternates submitted for bid.</td>
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<tr>
<td>Electrical Door Lock</td>
<td>Electric Strikes</td>
<td>HES</td>
<td>Series 1006, Series 5000, or Series 7000</td>
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<tr>
<td></td>
<td>Electrified Panic Devices</td>
<td>Von Duprin</td>
<td>Series 98 QEL (Quiet Electrified Latching)</td>
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<tr>
<td></td>
<td>Electro-magnetic lock</td>
<td>Securitron</td>
<td>Magnalock Model 32 or Model 62</td>
<td></td>
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<tr>
<td></td>
<td>Electrified Locksets</td>
<td>Command Access</td>
<td>LPM</td>
<td></td>
</tr>
<tr>
<td>Door Position Switch</td>
<td>Typical Door Position Switch</td>
<td>Sentrol</td>
<td>1078 series</td>
<td>Magnetic contacts</td>
</tr>
<tr>
<td></td>
<td>Roll-up Door Position Switch</td>
<td>Sentrol</td>
<td>2315-AL or 2515-AL series</td>
<td>Magnetic contacts</td>
</tr>
<tr>
<td>Door Management Alarm</td>
<td>Typical Door Management Alarm</td>
<td>Designed Security Inc.</td>
<td>ES4200-K1</td>
<td></td>
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<tr>
<td>Egress Components</td>
<td>Motion Detector</td>
<td>Bosch</td>
<td>DS 150i</td>
<td></td>
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<tr>
<td></td>
<td>Emergency Exit Push Button</td>
<td>Essex</td>
<td>PEBSS1-US 30 sec timer</td>
<td></td>
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<tr>
<td></td>
<td>Touch-Sense Bar</td>
<td>Securitron</td>
<td>TSB-3</td>
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<td>Alarm Detection Sensors</td>
<td>Glassbreak Sensor</td>
<td>Honeywell</td>
<td>IntelliSense FlexGuard FG-730</td>
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<td></td>
<td>Motion Sensor</td>
<td>Detection Systems</td>
<td>DS 835 Tri-Tech</td>
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<td>System Control Panel</td>
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<td>Software House</td>
<td>iSTAR Ultra</td>
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<tr>
<td>Power Supply</td>
<td>Controller Power Supply</td>
<td>Altronix</td>
<td>AL400ULXX</td>
<td>(1) 12ah Battery</td>
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<tr>
<td></td>
<td>Lock Power Supply</td>
<td>Altronix</td>
<td>AL400ULACM</td>
<td>(2) 7ah Batteries</td>
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<tr>
<td></td>
<td>REX and Individual Point Power Supply</td>
<td>Altronix</td>
<td>PD-8</td>
<td></td>
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<td></td>
<td>Von Duprin Door Hardware Power Supplies</td>
<td>Von Duprin</td>
<td>PS 873-2 BB</td>
<td>24 Volt DC Power Supply with Battery backup and 2 zone control board</td>
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<tr>
<td>Camera Systems</td>
<td>Video Management</td>
<td>March Networks</td>
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</table>
PART 3  EXECUTION

3.1 SYSTEM REQUIREMENTS & DESCRIPTION

A.  Access control systems shall include an Ethernet-ready embedded control panel, magnetic stripe card readers, magnetic locks, electric door strikes, door contacts, request for exit devices, emergency exit devices, door management alarms, power supplies, and necessary cabling as defined below. The control panels(s) shall communicate on the WU network to the West Campus server. The controller shall be configured to a University Services Network (USN) switch, provided by WU Network Technology Services or their approved sub-contractor. Security Contractor shall be responsible for programming controller with IP Address, Gateway and Subnet Mask Address. WU Network Technology Services will assist in establishing connection to the Campus Network and Card Access server.

B.  Submit updated, corrected shop drawings as a closeout submittal with the overall project closeout documents.

C.  Electrical power
   1.  System power supply: Provide 120V power from a generator backed panel, if available. System components shall be supplied with power through the system control panel or auxiliary power supplies supplied by installer.
   2.  Power source transfer: When normal power is interrupted, system shall automatically switch to backup supply without degradation of critical system function or loss of signals or status data.
      a.  Backup source: A dedicated power supply system rated to sustain full system load for 4 hours.
      b.  Annunciation: Switching of the system or any system components to back-up power is indicated on the system control panel as a change in system condition.

D.  Card readers
   1.  SSP shall identify on plan card reader locations and any necessary mounting hardware on shop drawings. Coordinate rough in requirements with design team and provide wiring back to the security control panel and connect.
   2.  Card readers shall be the magnetic strip type with a conformal coating and shall operate in either a star or daisy chain configuration.

E.  Electric door locks
   1.  Provide card access system connection to door lock that will release upon activation of card reader and by activation of door release device located on the interior side of the door or mechanical turn or push of hardware.
   2.  Electric strikes shall fail secure.
   3.  Electrified panic devices shall fail secure. Key override entry is required on these devices.
   4.  Electro-magnetic lock shall have a minimum of 600 lbs. holding force with a built in door status sensor.
   5.  Electrified locksets shall be electrified cylindrical. Switched power allows the outside lever to retract latch bolt. Inside lever shall always be free for immediate egress.
   6.  At interior doors that are installed with ADA power assist and electronic card access, provide electrified locksets with latch retraction.

F.  Door position switch
   1.  SSP shall identify on plan where a door contact shall be installed allowing for door status reporting.

G.  Door management alarm
1. SSP shall identify on plan where a door management alarm shall be installed allowing for local door alarm reporting.
2. Door management alarms shall be wired to an auxiliary output to allow WU to use the C-Cure software to bypass the DMA during specified hours.
3. Door management alarms shall be wired to an input to allow WU to remotely view the armed status of the device through the C-Cure software.

H. Egress components
1. SSP shall identify on plan where a motion detector shall be installed allowing for passive REX.
2. Motion REX devices shall be ceiling mounted, 18” or more from the doorframe. Devices shall not be mounted to the doorframe.
3. Identify on plan where an exit button shall be installed allowing for passive REX.
4. Identify on plan where a touch-sense exit bar shall be installed for REX when magnetic locks are being used on an exterior door.

I. Alarm detection sensors
1. SSP shall identify on plan where a glassbreak sensor shall be installed allowing for glass break detection and confirmation from a distance of 30’.
2. SSP shall identify on plan where motion sensors shall be installed allowing for passive infrared detection of movement.

J. System control panel
1. Provide lockable steel enclosure to house system control panel.
2. Arrange panel so normal operation, testing, and maintenance are performed from the front of the enclosure. If more than a single unit is required to form a complete control panel, provide matching modular unit enclosures. Accommodate all components to allow ample gutter space for interconnection of panels as well as field wiring.
3. Panel shall be per the product chart with an Access Control Module (ACMII) and any additional add-on input and output boards as necessary (I/8 or R/8).
   a. Panel shall have the capacity for (16) card readers. Both the motherboard and (2) ACM's will be co-located in one enclosure.
   b. Panel must have (5) I-8 input boards in a separate enclosure, installed adjacent to the panel enclosure. These (40) inputs will be available for “Security Loops” to be wired by WU Network Technology Services or their approved sub-contractor. This enclosure shall have its own separate 12V DC Power Supply within the enclosure.

K. Power supplies
1. Controller panel power supply shall be provided in a lockable steel enclosure.
2. Door lock panel power supply shall be provided in a lockable steel enclosure.
3. REX and individual point power supply shall be installed inside the controller can and powered from controller power supply.
4. Lock power supply shall be per the product chart. The WU PM and ACESO shall approve any alternates.

L. Miscellaneous hardware
1. Provide isolation relay for connection to fire alarm system. This relay must isolate the FACP from the door lock power supply and must not require the fire alarm relay to switch more than 100mA. The SSP shall coordinate connection to FACP.

M. Installation requirements
1. SSP shall install system and components according to applicable codes, industry standard, and manufacturer’s written instructions. The SSP shall obtain all necessary permits required by local authority in order to perform this installation.
2. All wiring shall be concealed in walls and above ceilings. Install wiring in raceways only in unfinished spaces and where subject to physical damage (such as mechanical rooms).
3. Consult with the WU PM to determine if wire mold is acceptable for elements of renovation projects.
4. Bundle, lace, and train the conductors to terminal points with no excess within enclosures. Provide and use lacing bars and distribution spools.
5. Provide number of conductors recommended by system manufacturer for required function.
6. Make splices, taps, and terminations on numbered terminal strips in junction, pull and outlet boxes, terminal cabinets, and equipment enclosures.
7. Color code conductors and apply wire and cable marking tape to designate wires and cables so media are identified and coordinated with system wiring diagrams.
8. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common mode returns, noise pickup, cross talk, and other impairments.

N. Field quality control
1. Provide factory-trained service representative to supervise the field assembly and connection of components and system pre-testing, testing, adjustment, and programming coordination.
2. Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
3. Align and adjust the system and perform pre-testing of all components, wiring, and functions to verify conformance with specified requirements. Correct deficiencies by replacing malfunctioning or damaged items with new items. Retest until satisfactory performance and conditions are achieved.
4. Perform operational system tests to verify conformance with the applicable standard. Test all modes of system operation and intrusion detection. Methodically test for false alarms in each zone of door intrusion detection devices by simulating activities outside indicated detection patterns.
5. Correct deficiencies and retest until the total system meets the requirements of the applicable standards.
EXTERIOR IMPROVEMENTS

The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes
   1. Concrete pavement
   2. Site improvements

B. Related sections
   1. Section 04 43 00 “Stone Masonry”
   2. Section 28 00 00 “Electronic Safety & Security”
   3. Section 26 05 00 “Common Work Results for Electrical”
   4. See the Introduction, Figures, Schedules, Appendices, and Resources for additional information.

PART 2 PROVIDERS & PRODUCTS

2.1 PRODUCTS

A. Specify rigid paving as follows:
   1. Specify a mockup for paving types above to review material and workmanship.
   2. WU Exposed Aggregate Pedestrian concrete mix design:

<table>
<thead>
<tr>
<th>Component</th>
<th>Type</th>
<th>Qty/CY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>ASTM C150, Type I/II</td>
<td>564 lbs</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>ASTM C618, Class C</td>
<td>47 lbs</td>
</tr>
<tr>
<td>Course Aggregate</td>
<td>ASTM C33, #57 Meramec Gravel</td>
<td>1,850 lbs</td>
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<tr>
<td>Fine Aggregate</td>
<td>ASTM C33 – Meramec Finish Sand</td>
<td>1,160 lbs</td>
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<tr>
<td>Design Air</td>
<td>ASTM C 260</td>
<td>6.0%</td>
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<tr>
<td>Air Entrainment</td>
<td>BASF MasterAir – AE90</td>
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<tr>
<td>Water Reducer</td>
<td>GRT KB-1200</td>
<td></td>
</tr>
<tr>
<td>Integral Color</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Surface retarder: Grace “TopCast” 100-Gray, 3/8” – 1/2” etching
3. WU Integral Color Bike Lane concrete mix design

<table>
<thead>
<tr>
<th>Component</th>
<th>Type</th>
<th>Qty/CY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>ASTM C150, Type I/II</td>
<td>600 lbs</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>ASTM C618, Class C</td>
<td>0 lbs</td>
</tr>
<tr>
<td>Course Aggregate</td>
<td>CM13 – 5/8” Limestone</td>
<td>1,780 lbs</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td>ASTM C33 – Mo/Mi River Sand</td>
<td>1,270 lbs</td>
</tr>
<tr>
<td>Design Air</td>
<td>ASTM C 260</td>
<td>6.0%</td>
</tr>
<tr>
<td>Air Entrainment</td>
<td>GRT Polychem SA</td>
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<tr>
<td>Water Reducer</td>
<td>GRT KB-1200</td>
<td></td>
</tr>
<tr>
<td>Integral Color</td>
<td>Solomon ColorFlo 920</td>
<td>4% load rate</td>
</tr>
</tbody>
</table>

Surface retarder: Grace “Face Off” 05-Powder Blue Violet, sand blast etching

B. Specify pre-formed thermoplastic pavement markings as follows:
   1. See the related sections for PDF and CAD files of the WU standard pavement markings.
   2. Approved material suppliers:
      a. Ennis Flint “Pre-Mark”, 125 mil (single ply) or 250 mil (double ply)
      b. Geveko Preform Thermoplastic “Optamark”, 125 mil (single ply) or 250 mil (double ply)

C. Specify cast-in-place tactile warning surfaces as follows:
   1. Neenah Foundry or EJ Duralast
      a. Cast iron natural finish, unless matching existing

D. Specify bicycle racks & repair stations as follows
   1. Landscape Forms “Emerson”
      a. Color: Black Matte
   2. Coordinate with the WU Office of Sustainability to specify the preferred bicycle repair station.

E. Specify trash receptacles as follows:
   1. Standard: Landscape Forms “Chase Park”
      a. Side opening, solid top, sign panel (sign provided by WU), no logo band, no sand pan
      b. Dimensions: 24” x 40”
      c. Color: Titanium
      d. Color for recycling tops: Ocean
   2. WU Maintenance leases and manages Big Belly trash receptacles.

F. Specify cubic benches as follows:
   1. Indiana limestone. Pre-cast concrete benches are not acceptable.

G. Specify fixed and removable bollards as follows:
   1. Fixed: Donat “DON100” or “DON101”
      a. Color: Matte RAL 9005 Jet Black
   2. Removable: Donat “DON150”
      a. Color: Matte RAL 9005 Jet Black
   3. Steel pipe bollards
      a. Specify hot dipped galvanized.
      b. Specify pre-cast concrete caps in lieu of site-cast concrete caps.
H. Specify auto retractable bollards as follows:
   1. FAAC “J275 HA V2 H800”
      a. Color RAL 7021
   2. Determine if a UL listing has been obtained from the manufacturer. If not, coordinate with WU PM for an on-site UL certification.
   3. Engage the WU Access Control sole source provider for design assistance.
   4. Indicate bollard spacing which prevents passage of motor vehicles but allows passage of WU golf carts, resulting in a clear spacing between 4’-6” to 5’-6”.

PART 3 EXECUTION

3.1 SPECIFICATION REQUIREMENTS

A. Include the following text in the appropriate section of the project specifications.
   1. Contractor shall completely mask off and shall not apply sealer to asphalt or concrete in areas to receive pavement markings.
   2. Contractor shall prime all concrete areas to receive pavement markings.
   3. Contractor shall apply thermoplastic adhesive in areas below pavement markings to avoid an adhesive-stained border around pavement marking.
   4. Contractor shall brush or roller apply sealer in area of pavement markings after installation of pavement markings. Contractor shall not apply sealer on pavement markings.
The Danforth Design Guide conveys crucial requirements design teams shall incorporate into the contract documents to achieve WU’s quality and performance expectations. The Guide does not relieve or limit the design team’s professional or contractual responsibility. Submit proposed deviations to the WU PM for approval.

PART 1 GENERAL

1.1 SUMMARY
A. Section includes
   1. Utility information per region of the campus
B. Related sections
   1. See the Introduction, Figures, Schedules, and Appendices for additional information.

1.2 DESIGN/PERFORMANCE REQUIREMENTS
A. General
   1. Project location determines the available utility services.
   2. Heating and chilled water supply temperatures reset based on outdoor air temperature. Select equipment for process loads or other non-seasonal internal loads to meet the load using the reset temperature. Request typical reset supply temperatures from the WU PM.
   3. Temperature differences (ΔT) are system/building minimums. Select each load at the largest ΔT that is lifecycle cost effective and above the building minimums.
B. Danforth Campus (unless noted otherwise)
   1. Electric
      a. Distribution system
         1) Ameren Missouri provides electric to the campus.
         2) Electric service on campus is available from the campus distribution system at a primary voltage of 4160 volt, 3 wire wye, and solidly grounded neutral.
         3) The distribution system is a loop configuration and a Cutler-Hammer 400E boric acid expulsion fuse protects each loop.
      b. Building design
         1) Design buildings to coordinate with the 400E fuses.
         2) Provide service to new buildings through (2) 600A non-fused loop switches, fused main switches, and transformation to utilization voltage.
         3) Modify or add service to existing facilities by integrating with the existing building service.
         4) Specify an electric meter for each building.
         5) The campus utility engineer designs the service entrance from the 5kV to the building low voltage over current protection device.
   2. Natural gas
      a. Distribution system
         1) Spire Energy provides natural gas to the campus.
         2) Natural gas is available at most locations from the campus gas distribution system.
         3) The distribution system pressure is 20 psig.
b. Building design
   1) Consult with the WU PM for information concerning the availability, location, and pressure of natural gas at any given building site.
   2) Specify a gas meter for each building.
   3) Regulate pressure at building entrance to a maximum of 2 psig.
   4) The campus utility engineer designs the natural gas service entrance.

3. Water
   a. Distribution system
      1) Missouri-American Water provides water to the campus.
      2) Water is master metered and the available water pressure on campus is nominally 90 psig.
      3) The source of both supplies is river water as cold as 40°F in the winter and as warm as 85°F in the summer.
      4) Water hardness is approximately 6.5 grains per gallon.
   b. Building design
      1) One water service entrance provides both domestic water and fire water into the building.
      2) Split the service inside the building to service domestic water and fire water.
      3) Coordinate with the WU PM to perform a flow test to determine residual pressures at various flows.
      4) Specify a domestic water meter.
      5) Do not specify a fire water meter.
      6) Do not specify a fire pump without demonstrating a need to the WU PM.
      7) The campus utility engineer designs the water service entrance.

4. Chilled water
   a. Distribution system
      1) WU operates and campus buildings connect to a one-pipe chilled water loop.
      2) The chilled water loop serves all space conditions for human comfort, all other loads which are not humidity critical, and all loads not required for critical operation.
      3) The nominal temperature of the supply chilled water will vary from 45°F to 50°F.
      4) When WU determines the campus loop requires a new chiller within a building, WU and the campus utility engineer will collaborate to design and separately bid the new chiller.
   b. Building design
      1) Design building systems with 50°F entering water temperature and building ΔT of 10°F or greater.
      2) Specify a BTU meter for building chilled water.
      3) The campus utility engineer designs the chilled water service entrance.

5. Heating
   a. Distribution system
      1) WU operates regional low pressure steam plants from approximately October 15 to May 15 and distributes steam at 10 psig maximum.
   b. Building design
      1) When the steam plant is not operating and the building requires summer heat, utilize a summer boiler, local heat recovery chiller, or connect to a regional heat recovery chiller where one exists.
      2) Provide space heating by designing a 5 psig steam to hot water heat exchanger at a maximum water temperature of 115°F with a building ΔT of 20°F or greater.
      3) Do not utilize campus steam for humidification or domestic hot water.
      4) Specify a BTU meter for building heating water.
      5) The campus utility engineer will design steam or heating water service entrance.
6. Storm and sanitary sewers
   a. System
      1) The Metropolitan St. Louis Sewer District (MSD) maintains a public combined storm and sanitary public sewer system.
      2) WU maintains a private sewer system, generally consisting of separated storm and sanitary piping, which discharges to MSD.
      3) WU and MSD maintain a combined storm water master plan.
   b. Building design
      1) Maintain full separation between storm and sanitary drainage within and around the building.
      2) Building projects may include a local upgrade of existing sewer systems. Coordinate with the WU PM to determine the appropriate point of connection to the existing private or public sewer systems.
      3) Design buildings to drain by gravity flow. WU prohibits pumps except for sub-soil drains below the storm sewer elevation.

7. Telecommunications
   a. The campus utility engineer will design copper and fiber to the building.

C. East End of the Danforth Campus
1. General
   a. The East End is the area east of Hoyt Drive and Wrighton Way, including Schnuck Pavilion, Sumers Welcome Center, and all other buildings to the east.

2. Electric
   a. Refer to Danforth Campus for other considerations.

3. Natural gas
   a. Refer to Danforth Campus for other considerations.

4. Water
   a. Distribution system
      1) St. Louis City provides water to this area of the campus.
      2) Water is master metered for the East End as defined above (regardless of City/County line) and the available water pressure in this area is nominally 75 psig.
   b. Refer to Danforth Campus for other considerations.

5. Chilled water
   a. Distribution System
      1) The East End has a separate chilled water system but operates similarly to the Danforth Campus.
   b. Refer to Danforth Campus for other considerations.

6. Heating
   a. Distribution system
      1) The East End has two interconnected heating water plants with 2-pipe distribution that operate all year.
   b. Building design
      1) Design heating systems for a maximum water temperature of 110°F with a building ΔT of 20°F or greater.
   c. Refer to Danforth Campus for other considerations.

7. Storm and sanitary sewers
   a. The East End has a lift station near Skinker Blvd. to protect East End buildings from sewer surcharges.
   b. Refer to Danforth Campus for other considerations.

8. Telecommunications
a. Refer to Danforth Campus for other considerations.

D. South Forty (S40) Campus
1. Electric
   a. Refer to Danforth Campus for other considerations.
2. Natural Gas
   a. Distribution system pressure is 5 psig.
   b. Refer to Danforth Campus for other considerations.
3. Water
   a. Distribution system
      1) There are separate systems for domestic water and fire water.
      2) Coordinate with the WU PM to perform a flow test to determine residual pressures at various flows for each system.
   b. Refer to Danforth Campus for other considerations.
4. Chilled water
   a. Distribution system
      1) WU operates a central chilled water plant with 2-pipe distribution.
      2) The system supplies 45°F chilled water.
   b. Building design
      1) Design buildings with pumps decoupled from the loop.
      2) Design building systems with the supply temperature above and a minimum building ΔT of 12°F or greater.
   c. Refer to the Danforth Campus for other considerations.
5. Heating
   a. Distribution system
      1) WU operates regional heating water plants.
   b. Building design
      1) Design building systems with a maximum water temperature of 120°F with a building ΔT of 20°F or greater.
   c. Refer to the Danforth Campus for other considerations.
6. Storm and sanitary sewers
   a. Refer to Danforth Campus for other considerations.
7. Telecommunications
   a. Refer to Danforth Campus for other considerations.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED
1) DO NOT SPECIFY FREE STANDING FIRE DEPARTMENT CONNECTIONS.
2) SPECIFY HUB DRAIN TO HANDLE DISCHARGE FLOW OF DRAIN DOWN OR TEST.
3) DANFORTH CAMPUS: SPLIT THE FIRE WATER AND DOMESTIC WATER FROM A COMMON LINE INSIDE THE BUILDING.
4) PROVIDE A DEDICATED, UNDERGROUND FIRE WATER SERVICE ENTRANCE ON THE SOUTH 40.
NOTE:
1) INSTALL PIG TAIL SIPHON BETWEEN GAUGE AND TEE ON STEAM PIPING.
NOTES:
1) DO NOT SPECIFY OR PERMIT DIELECTRIC UNIONS. SPECIFY TRANSITIONS PER DETAIL.
2) LINED WATERWAY NIPPLE BETWEEN STEEL AND COPPER IS ACCEPTABLE FOR INDOOR LOCATIONS.
3) SPECIFY ISOLATED FLANGES FOR EXTERIOR LOCATIONS OR OTHER MATERIAL TYPES.
NOTES:
1) REFER TO SECTION 22 05 00 & 23 05 00 "COMMON WORK RESULTS FOR PLUMBING & HVAC" FOR GAS METER AND STRAIGHT PIPE LENGTH REQUIREMENTS. LOCATE METER INSIDE THE BUILDING.
2) SPECIFY HUB DRAIN TO HANDLE DISCHARGE FLOW OF DRAIN DOWN OR TEST.
3) *AS REQUIRED
NOTES:
1) SPECIFY SAFETY YELLOW PAINT FOR EXTERIOR GAS PIPING. SPECIFY NO PAINTING OF PRE-FINISHED ITEMS.
NOTES:
1) SPECIFY SAFETY YELLOW PAINT FOR EXTERIOR GAS PIPING. SPECIFY NO PAINTING OF PRE-FINISHED ITEMS.
SV

VALVE THROTTLED FOR PRESSURE DROP

TEE ON TOP OF MAIN PIPING TO CAPTURE AIR

1/4" BALL VALVE FOR PRESSURE MEASUREMENT

2" AIR SEPARATOR

NOTES:
1) INTEGRATE THIS DETAIL FOR BUILDING CHILLED WATER AND BUILDING HEATING WATER SYSTEMS.
2) APPLY THIS DETAIL FOR LINE SIZES EQUAL TO OR GREATER THAN 5". SPECIFY A LINE SIZE SEPARATOR FOR SMALLER LINE SIZES.
GAUGE (GA)  
PRESSURE SNUBBER  
COPPER TUBING  

TEE WITH PETE'S PLUG (TYP OF 4)  
BRASS NIPPLES INTO PUMP CASING. NO DIRECTION CHANGE ALLOWED IN THIS ASSEMBLY.  

PUMP DISCHARGE  
PUMP SUCTION  
SUCTION DIFFUSER
NOTES:
1) THE DRAWING ABOVE IS A DANFORTH CAMPUS "TYPE 1" CONNECTION FOR BUILDINGS WITHOUT CHILLERS. WHEN A CHILLER IS REQUIRED, THE CAMPUS UTILITY ENGINEER WILL PROVIDE TYPE 2 OR 3 DETAILS SPECIFIC TO THAT BUILDING.
2) PIPING MAY BE DIFFERENT BASED ON ELEVATION OF INCOMING PIPING RELATIVE TO BUILDING PIPING. LOCATE DRAIN VALVES AT LOW POINT FOR BUILDING DRAINING. LOCATE AIR VENTS AT HIGH POINTS FOR BUILDING VENTING. REFER TO STANDARDS FOR AIR VENTS AND DRAIN VALVES.
DRAIN VALVES AND AIR VENTS AT HIGH AND LOW POINTS BASED ON GEOMETRY.

LOCATE FLOW METER ON SUPPLY OR RETURN PIPING FOLLOWING INSTALLATION INSTRUCTIONS FOR REQUIRED UPSTREAM AND DOWNSTREAM DIAMETERS.

FULL SIZE EMERGENCY HOOKUP VALVES

BUILDING CONTROL VALVE WITH 3/4" BALANCE VALVE BYPASS

AIR SEPARATOR LOCATED ON RETURN FOR LOW PRESSURE AND WARM WATER FOR LOW AIR SOLUBILITY. SEE FIGURE.
DRAIN VALVES AND AIR VENTS AT HIGH AND LOW POINTS BASED ON GEOMETRY

FULL SIZE BYPASS

FULL SIZE EMERGENCY HOOK UP VALVES

BTU METER

LOCATE FLOW METER ON SUPPLY OR RETURN PIPING FOLLOWING MANUFACTURER UPSTREAM AND DOWNSTREAM REQUIREMENTS.

LOCATE AIR SEPARATOR ON RETURN FOR LOW PRESSURE AND WARM WATER FOR LOW AIR SOLUBILITY. SEE FIGURE.
NOTES:
1) PIPING MAY BE DIFFERENT BASED ON ELEVATION OF INCOMING PIPING RELATIVE TO BUILDING PIPING. LOCATE DRAIN VALVES AT LOW POINT FOR BUILDING DRAINING. LOCATE AIR VENTS AT HIGH POINTS FOR BUILDING VENTING. REFER TO STANDARDS FOR AIR VENTS AND DRAIN VALVES.
2) REFER TO STANDARDS FOR HEATING WATER METER AND STRAIGHT PIPE LENGTH REQUIREMENTS.
BAS TEMPERATURE SENSORS
FULL SIZE EMERGENCY HOOK UP VALVES

AIR SEPARATOR LOCATED ON HWS BEFORE THE PUMPS FOR LOW PRESSURE AND WARM WATER FOR LOW AIR SOLUBILITY. SEE FIGURE.

BTU METER TEMPERATURE SENSOR

LOCATE FLOW METER ON SUPPLY OR RETURN PIPING FOLLOWING MANUFACTURER'S REQUIRED UPSTREAM AND DOWNSTREAM DIAMETERS.

FULL SIZE BYPASS

3/4" VENT

DRAIN VALVES AND AIR VENTS AT HIGH AND LOW POINTS BASED ON GEOMETRY

BTU METER

1-1/2" DRAIN

BUILDING CONTROL VALVE WITH 3/4" BALANCE VALVE BYPASS

DECOUPLED BUILDING LOOP
NOTES:
1) REFER TO STANDARD FOR STEAM TRAPS.
2) DETAIL STEAM CONTROL VALVE AND PIPING, INCLUDING INDICATING PIPE SLOPE DIRECTIONS, SO CONDENSATE DOES NOT COLLECT ON EITHER SIDE OF A CLOSED CONTROL VALVE.
3) SIZE CONDENSATE PUMP FOR 3'/100' EQUIVALENT PIPE LENGTH HEAD PLUS ELEVATION RISES BACK TO THE PLANT.

WU DANFORTH DESIGN GUIDE
REVISED 2021
STEAM - LOW PRESSURE STEAM & CONDENSATE ENTRANCE
FIGURE 23H
T1 = SYSTEM SUPPLY TEMPERATURE
T2 = SYSTEM RETURN TEMPERATURE
T3 = T2 = LWT
GPM2 = GPM1 + GPM3 (RECOMMENDED COIL TUBE VELOCITY = 1.3 FPS)
EWT = (GPM1 x T1 + GPM3 x T3) / GPM2

EXAMPLE - PREFERRED 2 TIMES THE SYSTEM FLOW, HALF THE SYSTEM DELTA T AT THE COIL

T1 = 115°F
T2 = 75°F
T3 = T2 = LWT
LOAD = 400,000 BTU/HR
GPM1 = 400,000 BTU/HR / (500 x (115°F - 75°F)) = 20 GPM
PICK GPM3 TO BE EQUAL TO GPM1 = 20 GPM
GPM2 = 20 GPM + 20 GPM = 40 GPM
EWT = (20 GPM x 115°F + 20 GPM x 75°F) / 40 GPM = 95°F

COIL: 400,000 BTU-HR; EWT = 95°F; GPM = 40; LWT = 75°F
*IF COIL SELECTION IS NOT +/- 1°F OF THE TARGET VALUE THEN IT IS NOT NECESSARY TO I TERATE THE ABOVE CALCULATION AND COIL SELECTION.
PUMP FLOW = 20 GPM
CONTROL VALVE FLOW = 20 GPM

SEQUENCE OF OPERATION

WHEN THE UNIT IS NOT OPERATING AND THE OUTDOOR AIR TEMPERATURE IS ABOVE 40°F, THE PREHEAT VALVE SHALL BE FORCED CLOSED BY SOFTWARE.

WHEN THE UNIT IS NOT OPERATING AND THE OUTDOOR AIR TEMPERATURE IS BELOW 40°F, THE PREHEAT VALVE SHALL MODULATE TO MAINTAIN MIXED AIR TEMPERATURE AT 60°F.

THE PREHEAT COIL PUMP SHALL OPERATE WHEN THE OUTDOOR TEMPERATURE IS LESS THAN 40°F WHETHER THE UNIT IS OPERATING OR NOT. IF THE UNIT IS OPERATING, THE OUTDOOR TEMPERATURE IS LESS THAN 40°F, AND THE PUMP IS NOT OPERATING AS DETERMINED BY THE PUMP CURRENT SWITCH, THEN THE UNIT SHALL BE STOPPED BY SOFTWARE (FOR NON-CRITICAL APPLICATIONS) AND AN ALARM NOTIFICATION SENT.

A HARDWIRE INTERLOCK SHALL OPEN THE HEATING VALVE, OPEN THE COOLING VALVE, STOP THE FANS, RETURN DAMPERS TO THEIR NORMAL POSITIONS, AND START THE PREHEAT COIL PUMP ANY TIME THE FREEZESTAT IS TRIPPED.

DISCHARGE TEMPERATURE CONTROL: THE PREHEAT VALVE SHALL MODULATE IN SEQUENCE WITH ECONOMIZER DAMPERS (IF APPLICABLE) AND CHILLED WATER VALVE TO MAINTAIN DISCHARGE TEMPERATURE SETPOINT.
NOTES:
1) SPECIFY ALUMINUM JUNCTION BOXES FOR CORROSION RESISTANCE.
2) COORDINATE FLOOR DRAIN LINE IN ADJACENT MECHANICAL ROOM.
3) JUNCTION BOX AND ELEVATION CHANGE ALLOW DRAINAGE SO WATER DOES NOT DRAIN INTO ELECTRICAL EQUIPMENT.
4) CONSIDER CABLE BENDING RADIUS WHEN LOCATING CONDUITS IN AND OUT OF THE JUNCTION BOX.
BRANCH CIRCUIT

T CONDUIT BODY

1" PIPE TO DRAIN

SLOPE CONDUIT AWAY FROM BUILDING
MECHANICAL RUBBER SEAL
SW 5KV SW 5KV SW 5KV SW

BUILDING LOADS

FIELD CONDUIT & WIRE

SWITCH IF BUILDING HAS 4160V CHILLER OR SECOND TRANSFORMER

3Ø TRANSFORMER
4160 - 480Y/277V OR 208Y/120V

BUILDING TRANSFORMER AND MAIN SWITCH

MAIN SWITCHBOARD

LOOP SWITCHES
METAL ENCLOSED SWITCHGEAR

NOTES:
1) DANFORTH CAMPUS: LOCATE LOOP SWITCHES INSIDE THE BUILDING.
ACCEPTABLE 5KV CABLE PATTERNS WHICH COMPLY WITH MINIMUM CABLE BENDING RADIUS.
FOR 500MCM, R = 18, MINIMUM 48" X 48" PULL BOX.

PULL BOX

4xR MIN.
NOTES:
1) COORDINATE FLOOR DRAIN IN ADJACENT MECHANICAL ROOM.
2) IF DUCTBANK ENTRANCE IS OUTSIDE OF TELECOM ROOM, SPECIFY A JUNCTION BOX PER "ELECTRIC - 5KV SERVICE ENTRANCE."
NOTES:
1) USE WU STANDARD MOBILITY SYMBOLS ON ALL ON-CAMPUS PROJECTS.
2) REQUIRE AND REVIEW SHOP DRAWINGS, INCLUDING QUANTITY, SIZE, THICKNESS, COLOR, LOCATION, AND LAYOUT.
3) 4" MINIMUM EDGE DISTANCE.
4) ENSURE THERMOPLASTIC MARKINGS ARE NOT INSTALLED OVER PAVEMENT JOINTS.
5) SEE STANDARDS FOR OTHER REQUIREMENTS.
### Table 1: Definition of Tiers

<table>
<thead>
<tr>
<th>Tier I</th>
<th>Tier II</th>
<th>Tier III</th>
<th>Tier IV</th>
<th>Tier V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low Complexity</td>
<td>Low Complexity</td>
<td>Average Complexity</td>
<td>High Complexity</td>
<td>Very High Complexity</td>
</tr>
<tr>
<td>Physical Plant Maintenance Workshops</td>
<td>General Office Buildings</td>
<td>Medical / Specialty Classroom Buildings</td>
<td>Engineering Labs and Wet Research Labs – Up to BSL2</td>
<td>Hospitals</td>
</tr>
<tr>
<td>Warehouses / Storage Facilities</td>
<td>Physical Plant</td>
<td>Security and University Police Buildings</td>
<td>Theaters, Performance Halls, Auditorium, Assembly Spaces</td>
<td>Museums and Archival Facilities</td>
</tr>
<tr>
<td>Utility Structures / Service Buildings</td>
<td>Manufacturing Workshops</td>
<td>Athletic and Recreation Facilities</td>
<td>Dining Halls and Food Service</td>
<td>Animal Research Facilities</td>
</tr>
<tr>
<td>Low Technology Flex Office Buildings</td>
<td>Mixed Use Parking Facilities</td>
<td>Libraries</td>
<td>Outpatient Surgical Center and Specialty Clinics</td>
<td>Specialty Research Labs – BSL3 and above</td>
</tr>
<tr>
<td>Standard Parking Structures</td>
<td>Academic and Medical Classroom Buildings</td>
<td>Dormitories and Student Housing</td>
<td>Telecom / Data Processing Facilities</td>
<td>Medical Labs</td>
</tr>
</tbody>
</table>

### Table 2: Fees per Tier

<table>
<thead>
<tr>
<th>Tier I</th>
<th>Tier II</th>
<th>Tier III</th>
<th>Tier IV</th>
<th>Tier V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to $50,000</td>
<td>8.6%</td>
<td>10.1%</td>
<td>11.5%</td>
<td>13.0%</td>
</tr>
<tr>
<td>Up to $100,000</td>
<td>8.4%</td>
<td>9.8%</td>
<td>11.2%</td>
<td>12.6%</td>
</tr>
<tr>
<td>Up to $250,000</td>
<td>8.0%</td>
<td>9.4%</td>
<td>10.7%</td>
<td>12.0%</td>
</tr>
<tr>
<td>Up to $500,000</td>
<td>6.9%</td>
<td>8.1%</td>
<td>9.3%</td>
<td>10.5%</td>
</tr>
<tr>
<td>Up to $1,000,000</td>
<td>5.7%</td>
<td>6.7%</td>
<td>7.6%</td>
<td>8.6%</td>
</tr>
<tr>
<td>Up to $5,000,000</td>
<td>5.4%</td>
<td>6.2%</td>
<td>7.1%</td>
<td>7.9%</td>
</tr>
<tr>
<td>Up to $10,000,000</td>
<td>5.0%</td>
<td>5.7%</td>
<td>6.4%</td>
<td>7.1%</td>
</tr>
<tr>
<td>Up to $25,000,000</td>
<td>4.9%</td>
<td>5.5%</td>
<td>6.1%</td>
<td>6.7%</td>
</tr>
<tr>
<td>Up to $50,000,000</td>
<td>4.9%</td>
<td>5.3%</td>
<td>5.7%</td>
<td>6.1%</td>
</tr>
</tbody>
</table>

1When the cost falls between tabular limits, determine rate by interpolation based on actual construction cost.

### Table 3: Fee Multiplier

<table>
<thead>
<tr>
<th>Multiplier</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50</td>
<td>Replacement of single system</td>
</tr>
<tr>
<td>0.60</td>
<td>Limited documentation</td>
</tr>
<tr>
<td>0.70</td>
<td>Interiors project to match existing conditions</td>
</tr>
<tr>
<td>0.80</td>
<td>Not requiring multiple basic service tasks</td>
</tr>
<tr>
<td>0.90</td>
<td>Not requiring one basic service task</td>
</tr>
<tr>
<td>1.00</td>
<td>Standard basic service contract</td>
</tr>
<tr>
<td>1.10</td>
<td>Scope in excess of standard basic services</td>
</tr>
<tr>
<td>1.20</td>
<td>Project requiring significant detailing to match adjacent architectural vocabulary</td>
</tr>
<tr>
<td>1.30</td>
<td>Project with multiple phases or documentation needs</td>
</tr>
<tr>
<td>1.40</td>
<td>Small complicated project</td>
</tr>
<tr>
<td>1.50</td>
<td>Iconic building</td>
</tr>
</tbody>
</table>
### FIRE SUPPRESSION PIPING

<table>
<thead>
<tr>
<th>Service</th>
<th>Size</th>
<th>Material</th>
<th>Schedule</th>
<th>Joints</th>
<th>Service/ Shut off</th>
<th>Balance/ Throttle</th>
<th>Check Valve</th>
<th>Temperature</th>
<th>Design Pressure (PSI)</th>
<th>Design Temp (°F)</th>
<th>Insulation Thickness</th>
<th>Insulation Type</th>
<th>Insulation Jacket</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Pipe</td>
<td>≤2&quot;</td>
<td>Carbon Steel</td>
<td>(1)</td>
<td>TCI</td>
<td>Ball</td>
<td>Swing</td>
<td></td>
<td>175</td>
<td>150</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2½&quot;</td>
<td>Carbon Steel</td>
<td>(2)</td>
<td>Grooved Cplng (3)</td>
<td>Butterfly</td>
<td>Swing</td>
<td></td>
<td>175</td>
<td>150</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry Pipe</td>
<td>≤2&quot;</td>
<td>Galv Steel</td>
<td>Sch. 40</td>
<td>TCI</td>
<td>Ball</td>
<td>Swing</td>
<td></td>
<td>175</td>
<td>150</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥2½&quot;</td>
<td>Galv Steel</td>
<td>Sch. 10</td>
<td>Grooved Cplng (3)</td>
<td>Butterfly</td>
<td>Swing</td>
<td></td>
<td>175</td>
<td>150</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below Grade</td>
<td>All HDPE</td>
<td>SDR 11</td>
<td>Butt Fusion (5)</td>
<td>(4)</td>
<td>(160)</td>
<td>(75)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### General & Keyed Notes

1. See the Design Guide for additional requirements.
2. Engineered Schedule 40 pipe which is UL listed, FM approved, and has a UL Corrosion Resistance Ratio = 1.0 is acceptable.
3. Cut grooves are not acceptable.
4. Specify resilient seat gate valves with curb box.
5. Electrofusion couplings are not acceptable.
## SCHEDULE 22A

### DOMESTIC COLD WATER - SUPPLY & RETURN PIPING

<table>
<thead>
<tr>
<th>Service</th>
<th>Size</th>
<th>Material</th>
<th>Schedule</th>
<th>Joints</th>
<th>Service/</th>
<th>Balance/</th>
<th>Check Valve</th>
<th>Pressure (PSI)</th>
<th>Temp (°F)</th>
<th>Thickness Type</th>
<th>(1) Type</th>
<th>Jacket</th>
</tr>
</thead>
<tbody>
<tr>
<td>AG Dom Cold Water - S&amp;R</td>
<td>½&quot;</td>
<td>Copper</td>
<td>Type L</td>
<td>95/5 Solder</td>
<td>Ball</td>
<td>Swing</td>
<td></td>
<td>175</td>
<td>150</td>
<td>¼” CR (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>¾&quot;</td>
<td>Copper</td>
<td>Type L</td>
<td>95/5 Solder</td>
<td>Ball</td>
<td>Swing</td>
<td></td>
<td>175</td>
<td>150</td>
<td>½” CR (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1&quot;</td>
<td>Copper</td>
<td>Type L</td>
<td>95/5 Solder</td>
<td>Ball</td>
<td>Swing</td>
<td></td>
<td>175</td>
<td>150</td>
<td>½” CR (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1¼&quot;</td>
<td>Copper</td>
<td>Type L</td>
<td>95/5 Solder</td>
<td>Ball</td>
<td>Swing</td>
<td></td>
<td>175</td>
<td>150</td>
<td>½” CR (2)</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>1½&quot;</td>
<td>Copper</td>
<td>Type L</td>
<td>95/5 Solder</td>
<td>Ball</td>
<td>Swing</td>
<td></td>
<td>175</td>
<td>150</td>
<td>½” CR (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2&quot;</td>
<td>Copper</td>
<td>Type L</td>
<td>95/5 Solder</td>
<td>Ball</td>
<td>Swing</td>
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<td>175</td>
<td>150</td>
<td>½” CR (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2¼&quot;</td>
<td>Copper</td>
<td>Type L</td>
<td>95/5 Solder</td>
<td>Ball</td>
<td>Swing</td>
<td></td>
<td>175</td>
<td>150</td>
<td>½” CR (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3&quot;</td>
<td>Copper</td>
<td>Type L</td>
<td>95/5 Solder</td>
<td>Ball</td>
<td>Swing</td>
<td></td>
<td>175</td>
<td>150</td>
<td>½” CR (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4&quot;</td>
<td>Copper</td>
<td>Type L</td>
<td>95/5 Solder</td>
<td>Ball</td>
<td>Swing</td>
<td></td>
<td>175</td>
<td>150</td>
<td>½” CR (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Galv Steel</td>
<td>Sch. 40</td>
<td>Grooved (3)</td>
<td>Butterfly</td>
<td>Silent</td>
<td></td>
<td>175</td>
<td>150</td>
<td>½” CR (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sch. 10</td>
<td>Rolled Groove</td>
<td>Butterfly</td>
<td>Silent</td>
<td></td>
<td>175</td>
<td>150</td>
<td>½” CR (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6&quot;</td>
<td>Copper</td>
<td>Type L</td>
<td>Grooved</td>
<td>Butterfly</td>
<td>Silent</td>
<td></td>
<td>175</td>
<td>150</td>
<td>½” CR (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Galv Steel</td>
<td>Sch. 40</td>
<td>Grooved (3)</td>
<td>Butterfly</td>
<td>Silent</td>
<td></td>
<td>175</td>
<td>150</td>
<td>½” CR (2)</td>
<td></td>
<td></td>
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<td>Butterfly</td>
<td>Silent</td>
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### General & Keyed Notes

A. See the Design Guide for additional requirements.

1. Minimum insulation thickness for interior conditioned space. Adjust for unconditioned or other environments.

2. Glass Fiber insulation of same thickness with ASJ is acceptable.


4. Specify resilient seat gate valves with curb box.

5. Electrofusion couplings not allowed.

### Abbreviations

AG: Above Grade

BG: Below Grade

CR: Cellular Rubber

GF: Glass Fiber

ASJ: All Service Jacket
# DOMESTIC HOT WATER - SUPPLY & RETURN PIPING

## SCHEDULE 22B

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<thead>
<tr>
<th>Service</th>
<th>Size</th>
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<th>Schedule</th>
<th>Joints</th>
<th>VALVES</th>
<th>DESIGN</th>
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### General & Keyed Notes
- **Abbreviations**
  - AG: Above Grade
  - CR: Cellular Rubber
  - GF: Glass Fiber
  - ASJ: All Service Jacket
- **A.** See the Design Guide for additional requirements.
- **1.** Minimum thickness for interior conditioned space. Adjust for unconditioned or other environments.
- **2.** Glass Fiber insulation of same thickness with ASJ is acceptable.
- **3.** Grooved connections not permitted in Residential Halls.
## SCHEDULE 22C
### SANITARY, VENT, & STORM PIPING

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<thead>
<tr>
<th>Service</th>
<th>Size</th>
<th>Material</th>
<th>Schedule</th>
<th>Joints</th>
<th>Valves</th>
<th>Pressure (PSI)</th>
<th>Temp (°F)</th>
<th>Thickness (1)</th>
<th>Type</th>
<th>Jacket</th>
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<td>Solvent</td>
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<td>PVC - SC</td>
<td>Sch. 40</td>
<td>Solvent</td>
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</table>

Acid Waste (See Design Guide)

### General & Keyed Notes
- **A.** See the Design Guide for additional requirements.
- **1.** Minimum thickness for interior conditioned space. Adjust for unconditioned or other environments.
- **2.** Where wet wall is not connected to the plenum.
- **3.** Insulate drains used for cooling condensate to prevent sweating.
- **4.** PVC is acceptable outside of return air plenums.
- **5.** Specify insulation on all horiz/vertical storm piping from the drain body down to one floor below the roof to limit noise and sweating.
- **6.** Perforated pipe with geo fabric.
- **7.** Specify standard duty no hub couplings.

### Abbreviations
- **BG:** Below Grade
- **AG:** Above Grade
- **SC:** Solid Core
- **NHC:** No Hub Coupling
- **CR:** Cellular Rubber
- **GF:** Glass Fiber
- **ASJ:** All Service Jacket
## Compressed Air Piping

### Schedule 22D

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<tr>
<th>Service</th>
<th>Size</th>
<th>Material</th>
<th>Schedule</th>
<th>Joints</th>
<th>Service/ Shut off</th>
<th>Balance/ Throttle</th>
<th>Check Valve</th>
<th>Pressure (PSI)</th>
<th>Temp (°F)</th>
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<td>95/5 Solder</td>
<td>Ball</td>
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### General & Keyed Notes
- A. See the Design Guide for additional requirements.
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<th>Schedule</th>
<th>Joints</th>
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<th>Balance/ Throttle</th>
<th>Check Valve</th>
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General & Keyed Notes

A. See the Design Guide for additional requirements.
## SCHEDULE 22F

### NATURAL GAS PIPING

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**General & Keyed Notes**

1. Specify PE ball valves with curb box.

**Abbreviations**

AG: Above Grade
BG: Below Grade
TMI: Threaded Malleable Iron
# CHILLED WATER - SUPPLY & RETURN PIPING

## SCHEDULE 23A

### DESCRIPTION

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<th>Service</th>
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<th>Schedule</th>
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<th>VALVES</th>
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**BG Chilled Water - S&R**

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<td>A. See the Design Guide for additional requirements.</td>
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<td>B. Exposed piping in mechanical rooms may be a hybrid with grooved couplings.</td>
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<td>1. Insulation thickness is minimum requirement for interior conditioned space. Adjust for unconditioned or other environments.</td>
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<td>2. Specify resilient seat gate valves with curb box.</td>
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<td>3. Electrofusion couplings not acceptable.</td>
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### Abbreviations

- AG: Above Grade
- BG: Below Grade
- CR: Cellular Rubber
- PI: Polyisocyanurate (25/50 rated in Plen)
- TCI: Threaded Cast Iron
## SCHEDULE 23B
### CONDENSER WATER - SUPPLY & RETURN PIPING

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### General & Keyed Notes
- A. See the Design Guide for additional requirements.
- B. Specify insulation on heated, exterior piping for towers which remain wet year round.
- C. Specify resilient seat gate valves with curb box.
- D. Electrofusion couplings not allowed.

### Abbreviations
- AG: Above Grade
- BG: Below Grade
- CR: Cellular Rubber
- PI: Polyisocyanurate (25/50 rated in Plen)
- TCI: Threaded Cast Iron
### SCHEDULE 23C

#### HEATING WATER - SUPPLY & RETURN PIPING

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#### Abbreviations
- AG: Above Ground
- BG: Below Ground
- GF: Glass Fiber
- TCI: Threaded Cast Iron

#### General & Keyed Notes
1. Insulation thickness is minimum requirement for interior conditioned space. Adjust for unconditioned or other environments.
2. Exposed piping in mechanical rooms may be a hybrid with grooved couplings.
# STEAM SUPPLY PIPING - HIGH & MEDIUM PRESSURE

## DESCRIPTION

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<th>Material</th>
<th>Schedule</th>
<th>Joints</th>
<th>Service/ Shut off</th>
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<th>Check Valve</th>
<th>Pressure (PSI)</th>
<th>Temp (°F)</th>
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### General& Keyed Notes

A. See the Design Guide for additional requirements.

1. Minimum thickness for interior conditioned space. Adjust for unconditioned or other environments.

### Abbreviations

- **AG**: Above Grade
- **BG**: Below Grade
- **TCI**: Threaded Cast Iron
- **GF**: Glass Fiber
- **ASJ**: All Service Jacket
# SCHEDULE 23E

## STEAM SUPPLY PIPING - LOW PRESSURE

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### General & Keyed Notes

- **AG**: Above Grade
- **BG**: Below Grade
- **TCI**: Threaded Cast Iron
- **GF**: Glass Fiber
- **ASJ**: All Service Jacket

A. See the Design Guide for additional requirements.

1. Minimum thickness for interior conditioned space. Adjust for unconditioned or other environments.
## SCHEDULE 23F

### STEAM CONDENSATE PIPING - PUMPED

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### General & Keyed Notes
- A. See the Design Guide for additional requirements.
- 1. Minimum thickness for interior conditioned space. Adjust for unconditioned or other environments.

### Abbreviations
- AG: Above Grade
- BG: Below Grade
- TCI: Threaded Cast Iron
- GF: Glass Fiber
- ASJ: All Service Jacket
## SCHEDULE 23G

### STEAM CONDENSATE PIPING - HIGH PRESSURE

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<td>350</td>
<td>4½” GF</td>
<td>ASJ</td>
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<td></td>
<td>6”</td>
<td>Carbon Steel</td>
<td>Sch. 40</td>
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<td>Gate Swing 100</td>
<td>350</td>
<td>4½” GF</td>
<td>ASJ</td>
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### General & Keyed Notes

A. See the Design Guide for additional requirements.

1. Minimum thickness for interior conditioned space. Adjust for unconditioned or other environments.

### Abbreviations

TCI: Threaded-Cast Iron
GF: Glass Fiber
ASJ: All Service Jacket
# SCHEDULE 23H

## STEAM CONDENSATE PIPING - LOW PRESSURE

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<th>Service</th>
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<th>Material</th>
<th>Schedule</th>
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<th>Service/Shut off</th>
<th>Balance/Throttle</th>
<th>Check Valve</th>
<th>Pressure (PSI)</th>
<th>Temp (°F)</th>
<th>Thick</th>
<th>Type</th>
<th>Jacket</th>
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### General & Keyed Notes

A. See the Design Guide for additional requirements.

1. Minimum thickness for interior conditioned space. Adjust for unconditioned or other environments.

### Abbreviations

- TCI: Threaded-Cast Iron
- GF: Glass Fiber
- ASJ: All Service Jacket
- PS: Pressure Supply
- RS: Return Supply
- LS: Low Service
- HS: High Service
- PS: Pressure Supply
- RS: Return Supply
- LS: Low Service
- HS: High Service
- TCI: Threaded-Cast Iron
- GF: Glass Fiber
- ASJ: All Service Jacket
April 10, 2020

Mr. David Baca, P.E.
Washington University in St. Louis
1 Brookings Drive
St. Louis, Missouri 63130

Dear Mr. Baca:

Washington University in St. Louis (WU) engaged Geotechnology to analyze existing geotechnical data and prepare a map to indicate the applicable seismic site classification in accordance with the International Building Code (IBC) for various areas of the campus. A summary of the background, analysis, and results is presented below.

WU regularly initiates renovation projects in existing buildings that do not warrant a full, site-specific geotechnical report. However, design teams often require a seismic site class designation for miscellaneous structural, mechanical, electrical, and plumbing modifications. While WU has significant historical archives of geotechnical information, this raw data has not been analyzed to evaluate a seismic site class in accordance with modern codes. The objective of this study was to develop a map showing a building’s seismic site class utilizing existing geotechnical data for renovation projects on the Danforth Campus and South 40. The results of the study should not be used for new building construction.

To begin the analysis, Geotechnology determined the depth from the ground surface to bedrock surface. Washington University provided the ground surface profile developed from geospatial surveys. The bedrock surface profile was created using 276 borings from existing geotechnical reports and 3 geophysical surveys (Table 1). The subsurface data was input into Surfer, an industry standard contouring application, which produced a top of bedrock contour map. The data was cross-checked to confirm accuracy of the historical reports (primarily with respect to surface elevation) and adjustments were made as needed to correlate to current conditions. These adjustments included evaluating basement elevations of the structures.

Based on our review of the available boring data, our familiarity with soil strength and shear wave velocity data on campus, and our engineering analysis, we have determined a conservative site classification for a majority of areas of the campus. For projects in buildings with 30’ or less between the ground surface or bottom of
basement elevation and the bedrock surface, or for buildings where geophysical surveys were completed to assess the site classification, Site Class “C” in accordance with IBC 2018 and preceding IBC codes is recommended. The remaining buildings may be classified as Site Class “D”. The extents of these classifications are shown on the Seismic Site Classification Map (Figure 1).

If you have any question related to this study, please do not hesitate to contact me.

Respectfully submitted,

GEOTECHNOLOGY, INC.

Joel A. Weinhold, P.E
Regional Manager

Figure 1: Seismic Site Classification Map
Table 1: Reference Geotechnical Reports
NOTES
1. Basemap provided by Washington University.


LEGEND
- Site Class "C"
- Site Class "D"
- Data Point - Boring Drilled to Refusal or Deeper
- Data Point - MASW Survey Array

Washington University
St. Louis, Missouri

SEISMIC SITE
CLASSIFICATION MAP

Drawn By: WAH
Ck'd By: JAW
App'd By: JAW

Date: 4-10-20
Date: 4-10-20
Date: 4-10-20

Project Number
JO0436.01

FIGURE 1
<table>
<thead>
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<th>Table 1 – Reference Geotechnical Reports</th>
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<tr>
<td>Miscellaneous Rock refusal Information, Washington University, St. Louis, Missouri, by Reitz &amp; Jens, Inc., and dated December 1972</td>
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<tr>
<td>Washington University, earth &amp; Planetary Science Center, St. Louis, Missouri, by Reitz &amp; Jens, Inc., Report No. 88-41, and dated July 1988</td>
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<tr>
<td>GDR - RDP Tributaries (Deer Creek) CSO Tunnel, by Shannon &amp; Wilson, Inc., Project No. SW 41-1-37530-008, November 2019</td>
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<tr>
<td>Geotechnical Engineering Report, Washington University, Biomedical Engineering Building, St. Louis, Missouri, by Shannon &amp; Wilson, Inc., Report No. 41-1-03137.001, and dated December 6, 1999</td>
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Washington University, Executive Education Center, Clayton, Missouri, by Shannon & Wilson, Inc., Report No. M-2781-01, dated ?

Proposed McKelvey Hall at Washington University, North Skinker Boulevard and Brookings Drive, St. Louis, Missouri, by Professional Service Industries, Inc., Report No. 0040215-1 Rev. 1, and dated March 12, 2018


Subsurface Exploration, Washington University, Student Housing, St. Louis, Missouri, by Geotechnology, Inc., Report No. J010094.01, and dated March 24, 2008

Addendum Number 2, Subsurface Exploration, Washington University, Student Housing, St. Louis, Missouri, by Geotechnology, Inc., Report No. J010094.03, and dated June 3, 2008


Subsurface Exploration, Student Housing Phase II, Washington University, St. Louis, Missouri, by Geotechnology, Inc., Report No. J003609.01, and dated October 23, 1996


Underground Parking Garage, Washington University, University City, Missouri, by Shannon & Wilson, Inc., Report No. 41-1-36176-001, and dated April 2005

Subsurface Investigation and Foundation Recommendation for a Plant Growth Facility at Washington University in St. Louis, Missouri, by Reitz & Jens, Inc., dated April 3, 1986


Surface Shear Wave Surveys, Washington University, St. Louis, Missouri, by Geotechnology, Inc., Report No. J035435.01, and dated April 7, 2020

Subsurface Exploration, Throop Building, Washington University, St. Louis, Missouri, by Geotechnology, Inc., Report No. J007592.01, and dated June 29, 2004

Subsurface Exploration, Social Sciences / Law Building, Washington University, St. Louis, Missouri, by Geotechnology, Inc., Report No. J007592.02, and dated August 27, 2004
1.1 INTRODUCTION

A. This manual is a compilation of standards and other information pertaining to the format of all CAD drawings created for Washington University (WU). WU requires all Consultants and University staff to adhere to these standards when creating drawings.

B. WU intends for Consultants to utilize their own drafting standards and CAD systems while still allowing WU to utilize the drawings in its system without complications. To achieve this goal, WU requires compliance with several mandatory requirements. Deviations from these requirements will result in design phase comments and record document rejection. The Consultant is responsible for liabilities caused by non-compliance with this manual.

C. Consultants shall request certain standard and existing conditions data to assist in creating drawings compatible with the WU system:
   1. WU standard Title Blocks
   2. As-built, record document, GIS, survey, and other information identified in the WU Design Guide

D. Due to the ability of the recipient to manipulate CAD data, WU disclaims any and all responsibility for said data. Consultants are fully responsible for field verification and/or drawing verification of all information provided by WU.

E. WU will not notify Consultants if base drawings or other provided data is changed or updated. The Consultant is responsible for assuring the accuracy of their product.

F. The WU standard service agreements refer to this manual and contains other requirements beyond the scope of this document. Present any discrepancies or deviations between the two documents to the attention of the WU Project Manager (PM) for clarification and approval.

G. The WU standard service agreements dictate that construction documents prepared for WU are the property of the University. Consultants shall transfer electronic files to WU upon completion of the project.

1.2 GRAPHIC STANDARDS

A. Title block & page layout
   1. Use a WU standard title block as shown below.
   2. Complete each section on the title block for contact information and license authorization.
   3. Create all drawings on one of two sheet sizes:
      a. 30" x 42"
      b. 24" x 36"
   4. Label sheets per industry standards and confirm labeling convention during the SD phase.

B. Drawing environment
   1. Utilize the AutoCAD 2018 .dwg file format.
   2. Coordinate system & origin
      a. Create drawings with the UCS set equal to the World Coordinate System (default setting).
b. Reference the NAD 1983 STATE PLANE MISSOURI coordinate system for all site plans and new construction buildings.

c. Maintain a consistent origin point between all CAD files in a project.

3. Drawing orientation & scale
   a. Layout the sheet with the north arrow oriented up.
   b. Include original column grids to identify project location when working in existing buildings.
   c. Include a drawing title, graphic scale, written scale, and north arrow on all plan sheets. Do not locate the graphic scale in the title block or set binding
d. Draw schedules, riser diagrams, single line diagrams, and other schematic diagrams to any scale.

4. Drawing units & dimensioning
   a. Utilize architectural units (feet and inches) in architectural CAD files.
   b. Utilize decimal units (feet and hundredths) in civil CAD files.
   c. Dimension items according to industry standards. Review any exceptions with the WU PM.
d. Maintain consistent dimension styles between CAD files within a project.

5. File and layer naming
   a. Name drawings with the sheet number at the beginning of the filename and balance of the filename per the Consultant’s standards.
      1) Example: A210_FloorPlanLevel1.dwg
      2) Example: S301_FoundationSections.dwg
   b. Name layers to convey the location and content of each layer.
      1) Example: A-RCP-ELEC for electrical items on the architectural reflected ceiling plan.
      2) Example: S-DET-REINF for steel reinforcement on the structural details.
      3) Numbered layering systems are unacceptable.

6. Graphics and symbols
   a. Utilize blocks to increase graphic uniformity whenever possible.
   b. Create blocks conforming to industry standards on recent CAD systems with minimal file size.
   c. Include a legend to identify blocks and symbols.
d. Utilize firm-specific graphic symbols, e.g., north arrows, detail symbols, partition types, etc.

7. Hatching
   a. Utilize hatching to improve drawing readability but refrain from excessive hatching.
   b. Apply hatch patterns only as CAD Object Types.
c. Do not use lines, polylines, images, or any other custom hatching.

8. Entities
   a. Create curved entities (circles, arcs, ellipses) as individual geometries, not of line segments.
   b. Set entity properties such as color, line weight, and line type as BYLAYER for purposes of clarity.
c. Set line type scale so each line type is recognizable and distinguishable to individuals working in the CAD files and the final plotted output.

9. Text requirements
   a. Visible text shall reflect attributed data of the CAD geometry.
   b. Place text in the CAD file with adequate clear space to allow for legibility in the plotted CAD file.
c. Typically, place text at 0° or 90° so it is readable from the bottom or right edge of the plotted sheet.
d. Text aligned with an object at an angle other than 0 or 90 degrees is acceptable.

C. Drawing & file submission requirements
   1. Remove extraneous objects beyond the drawing extents to ensure faster regens and efficient manipulation of the CAD files.
   2. Submit drawings with external references (X-Ref’s) bound to the individual drawings. X-ref’s with CAD submittals are not acceptable.
   3. Save and submit CAD files to meet the following requirements:
a. Ensure all X-Ref files are bound to their respective local file.
b. Toggle layers on or off to ensure the CAD file matches the plotted file.
c. Do not explode blocks.
d. Purge drawings.
e. Zoom drawing to extents.
f. For closeout submissions, ensure electronic CAD files reflect “as-built” conditions.

4. Include all pertinent electronic support files with the submittal, e.g., special fonts, hatch patterns, line types, color-dependent plot style tables (.ctb), .pc3 files, etc.

5. Package drawings in a primary folder containing the following label information:
   a. WU project #
   b. Project name
   c. Project phase/description
NOTES:
1) JOB TITLE: CONTRACT / GRADUATE STUDENT / INTERN
2) TYP 5X6 & 6X6 WORKSTATIONS
NOTES:
1) JOB TITLE: DEPARTMENT ADMINISTRATIVE ASSISTANT
2) TYP 6X8 WORKSTATIONS (48 SF)
NOTES:
1) JOB TITLE: ADMINISTRATIVE ASSISTANT
2) TYP 8X8 WORKSTATIONS (64 SF)
NOTES:
1) JOB TITLE: MANAGER, ASSOCIATE, ASSISTANT
2) TYP 10X12 OFFICE (120 SF)
NOTES:
1) JOB TITLE: DIRECTOR
2) TYP 12X12 & 12X14 OFFICE
NOTES:
1) JOB TITLE: DIRECTOR
2) TYP 12X12 & 12X14 OFFICE
NOTES:
1) JOB TITLE: DIRECTOR
2) TYP 12X12 & 12X14 OFFICE
NOTES:
1) JOB TITLE: EXECUTIVE / CHAIR PERSON
2) TYP 12X16 OFFICE (192 SF)
Notes:
1) Clearances & Mounting Heights, Typ
2) 2009 ANSI A117.1
4'-0" MAX FOR CONTROLS
3'-2" MIN
5'-0" TO UNIT
5'-6" TO UNIT
6'-0" TO UNIT

SHELF WITH MOP & BROOM HOLDER & HOOKS
SHELF WITH MOP & BROOM HOLDER & HOOKS
MOP & BROOM HOLDER

8"x24" UTILITY SHELF
MOP HOLDER (TBA)
CONTROLS
SERVICE RECEPTOR

JANITOR'S CLOSET FRONT WALL
JANITOR'S CLOSET SIDE WALL

NOTES:
1) CLEARANCES & MOUNTING HEIGHTS, TYP
2) 2009 ANSI A117.1
COORDINATE ALL MOUNTING DEVICES WITH SPECIFICATIONS

NOTES:
1) CLEARANCES & MOUNTING HEIGHTS, TYP
2) 2009 ANSI A117.1
NOTES:
1) CLEARANCES & MOUNTING HEIGHTS, TYP
2) 2009 ANSI A117.1
INSTALLATION AND FASTENING METHODS USED FOR GRAB BARS SHALL MEET MINIMUM STRUCTURAL REQUIREMENTS OF APPLICABLE HANDICAP CODES. IF HEIGHT SHOWN CONFLICTS WITH APPLICABLE CODES OR MANUFACTURERS RECOMMENDED INSTALLATION - REQUEST CLARIFICATION PRIOR TO ROUGH-IN AND INSTALLATION.
NOTES:
1) CLEARANCES & MOUNTING HEIGHTS, TYP
2) 2009 ANSI A117.1
GENERAL MOUNTING HEIGHT NOTES

A. IT IS THE INTENT OF THE DESIGN THAT ALL ITEMS SHOWN MOUNTED AT TYPICAL HEIGHTS BE ACCESSIBLE TO PERSONS WITH DISABILITIES.

B. THE PURPOSE OF THIS SHEET IS TO ILLUSTRATE TYPICAL MOUNTING HEIGHTS AND - WHERE APPLICABLE - TYPICAL MINIMUM OR MAXIMUM CLEARANCES AND/OR TYPICAL MOUNTING CONFIGURATIONS FOR A VARIETY OF ITEMS. CAUTION: THIS SHEET MAY ILLUSTRATE ITEMS OR CONFIGURATIONS WHICH DO NOT OCCUR AS PART OF THE WORK OF THIS PROJECT. REFER TO THE PLANS, ELEVATIONS, SECTIONS, DETAILS, AND SCHEDULES TO DETERMINE WHICH ITEMS AND CONFIGURATIONS APPLY TO THE WORK OF THIS PROJECT.


EXCEPTION: DIMENSIONED LOCATIONS SHOWN ON DRAWINGS OF OTHER DISCIPLINES SHALL GOVERN ONLY WHERE:

1. SPECIFICALLY AND INDIVIDUALLY INDICATED BY SYMBOL, KEYED NOTE, OR NOTATION ON THE A-SERIES DRAWINGS.
2. OCCURRING WITHIN A ROOM OR OTHER IDENTIFIABLE SPACE FOR WHICH A-SERIES SHEET OR SCHEDULE NOTES INDICATE THAT DIMENSIONS PROVIDED ELSEWHERE SHALL GOVERN.

D. THE MOUNTING HEIGHTS, CLEARANCES, AND CONFIGURATIONS SHOWN ON THIS SHEET ARE TYPICAL AND SHALL APPLY TO ALL INSTANCES OF THE ITEM (OR GROUP OF ITEMS) SHOWN UNLESS SPECIFICALLY NOTED OR DIMENSIONED OTHERWISE.

E. SPECIAL OR NON-TYPICAL MOUNTING HEIGHTS OCCUR ONLY WHERE INDICATED BY ANNOTATED SYMBOLS; BY KEY NOTES; BY NOTES ON PLANS, ELEVATIONS, OR DETAILS; OR BY UNIQUE DIMENSIONS ON ELEVATIONS OR DETAILS.

F. TYPICAL MOUNTING HEIGHTS FOR ADDITIONAL ITEMS NOT SHOWN ON THIS SHEET MAY BE ILLUSTRATED BY OTHER SHEETS. REFER TO THE "INDEX OF DRAWINGS" FOR ADDITIONAL INFORMATION.

G. MOUNTING CONFIGURATION DIAGRAMS ARE ELEVATIONS WHICH ILLUSTRATE TYPICAL RULES GOVERNING THE RELATIONSHIPS BETWEEN, AND PLACEMENT OF, ITEMS WHICH OCCUR IN GROUPS OF RELATED ITEMS OR IN CLOSE PROXIMITY TO OTHER PARTS OF THE WORK (SUCH AS SWITCHES AND DOOR FRAMES). UNLESS OTHER MOUNTING CONFIGURATIONS ARE SPECIFICALLY NOTED, DIMENSIONED, OR ELEVATED, THE TYPICAL RELATIONSHIPS, ARRANGEMENTS, AND THE TYPICAL CONFIGURATION DIAGRAMS APPLY THROUGHOUT THE WORK OF THIS PROJECT.

H. TACTILE EXIT SIGNS. A TACTILE EXIT SIGN STATING "EXIT" AND COMPLYING WITH ICC A117.1 SHALL BE PROVIDED ADJACENT TO EACH DOOR TO AN EGRESS STAIRWAY, AN EXIT PASSAGeway AND EXIT DISCHARGE.

NOTES:
1) GENERAL MOUNTING HEIGHT NOTES
2) 2009 ANSI A117.1
WHEN NOT DIMENSIONED AND SHOWN LOCATED ON A COLUMN OR PILASTER, AND WHEN NO OTHER TYPICAL CONFIGURATION DIAGRAM APPLIES: HORIZONTALLY CENTER GROUP OF SIMILAR ITEMS HAVING THE SAME MOUNTING HEIGHT(S) ABOUT THE CENTERLINE OF THE COLUMN OR PILASTER.

RULE 1

ARRANGE ITEMS AT SAME HEIGHT SYMMETRICALLY ABOUT CENTERLINE

NOT DIMENSIONED AND LOCATED ON COLUMN OR PILASTER

NOTES:
1) TYP RULES FOR DETERMINING MOUNTING HEIGHTS, LOCATIONS, & CONFIGURATIONS
2) 2009 ANSI A117.1
WHEN NOT DIMENSIONED AND SHOWN LOCATED ON A COLUMN OR PILASTER, AND WHEN NO OTHER TYPICAL CONFIGURATION DIAGRAM APPLIES: HORIZONTALLY CENTER GROUP OF DISSIMILAR ITEMS HAVING CONFLICTING MOUNTING HEIGHT(S) ABOUT THE CENTERLINE OF THE COLUMN OR PILASTER.

ARRANGE ITEMS AT CONFLICTING HEIGHTS SYMMETRICALLY ABOUT CENTERLINE

RULE 2

NOT DIMENSIONED AND LOCATED ON COLUMN OR PILASTER

NOTES:
1) TYP RULES FOR DETERMINING MOUNTING HEIGHTS, LOCATIONS, & CONFIGURATIONS
2) 2009 ANSI A117.1
WHEN NOT DIMENSIONED AND SHOWN LOCATED ADJACENT TO STRIKE SIDE OF DOOR, AND WHEN STRIKE-SIDE CLEARANCE IS BETWEEN 12 INCHES AND 18 INCHES, AND WHEN NO OTHER TYPICAL CONFIGURATION DIAGRAM APPLIES: MOUNT ITEMS IN RELATION TO FRAME USING TYPICAL OFFSET DIMENSION. VERTICALLY ALIGN CENTERS OF ITEMS MOUNTED AT DIFFERENT HEIGHTS.

WHEN MULTIPLE ITEMS HAVING THE SAME TYPICAL MOUNTING HEIGHT ARE INDICATED, MOUNT FIRST ITEM IN RELATION TO FRAME USING TYPICAL OFFSET DIMENSION AND PLACE REMAINING ADJACENT TO FIRST ON SIDE OPPOSITE FRAME AS ILLUSTRATED BY THIS DIAGRAM. DO NOT CROWD MULTIPLE ITEMS AGAINST WALL OR RESTRICTION.

NOT DIMENSIONED AND LOCATED ADJACENT TO MINIMUM STRIKE-SIDE OF DOOR

RULE 3

NOTES:
1) TYP RULES FOR DETERMINING MOUNTING HEIGHTS, LOCATIONS, & CONFIGURATIONS
2) 2009 ANSI A117.1
SIMILAR RULE APPLIES WHEN ADJACENT TO WINDOW.

FOR PURPOSES OF THESE RULES, ITEMS SHOWN LOCATED APPROXIMATELY WITHIN 4 FEET OF DOOR ARE CONSIDERED TO BE ADJACENT TO DOOR (OR WINDOW).

MULTIPLE ITEMS AT SAME HEIGHT
WHEN PROVIDED, UTILIZE TYPICAL MOUNTING DIAGRAMS TO DETERMINE DIMENSIONS

RULE 4

NOT DIMENSIONED AND LOCATED ADJACENT TO DOOR OR WINDOW

NOTES:
1) TYP RULES FOR DETERMINING MOUNTING HEIGHTS, LOCATIONS, & CONFIGURATIONS
2) 2009 ANSI A117.1
WHEN NOT DIMENSIONED AND SHOWN LOCATED ADJACENT TO DOOR, AND WHEN NO OTHER TYPICAL CONFIGURATION DIAGRAM APPLIES: MOUNT ITEMS IN RELATION TO SWING USING TYP OFFSET DIMENSION. VERTICALLY ALIGN CENTERS OF ITEMS MOUNTED AT DIFFERENT HEIGHTS.

WHEN MULTIPLE ITEMS HAVING THE SAME TYPICAL MOUNTING HEIGHT ARE INDICATED, MOUNT FIRST ITEM IN RELATION TO SWING USING TYPICAL OFFSET DIMENSION AND PLACE REMAINING ITEMS ADJACENT TO FIRST ON SIDE OPPOSITE FRAME AS ILLUSTRATED BY THIS DIAGRAM.

FOR PURPOSES OF THESE RULES, ITEMS SHOWN LOCATED APPROXIMATELY WITHIN 4 FEET OF OPEN DOOR ARE CONSIDERED TO BE ADJACENT TO DOOR.

WHERE MULTIPLE DISSIMILAR ITEMS HAVING CONFLICTING MOUNTING HEIGHTS OCCUR, RULE 13 ALSO APPLIES.

RULE 5

NOT DIMENSIONED AND LOCATED ADJACENT TO DOOR AND ON WALL AGAINST WHICH DOOR SWINGS

NOTES:
1) TYP RULES FOR DETERMINING MOUNTING HEIGHTS, LOCATIONS, & CONFIGURATIONS
2) 2009 ANSI A117.1
WHEN NOT DIMENSIONED AND SHOWN LOCATED ADJACENT TO CHANGE IN PLANE OF WALL, AND WHEN NO OTHER TYPICAL CONFIGURATION DIAGRAM APPLIES: MOUNT ITEMS IN RELATION TO PLANE CHANGE USING TYPICAL OFFSET DIMENSION. VERTICALLY ALIGN CENTERS OF ITEMS MOUNTED AT DIFFERENT HEIGHTS.

WHEN MULTIPLE DISSIMILAR ITEMS HAVING CONFLICTING MOUNTING HEIGHTS ARE INDICATED, MOUNT FIRST ITEM IN RELATION TO PLANE CHANGE USING TYPICAL OFFSET DIMENSION. SEPARATE DISSIMILAR ITEM FROM GROUP OF SIMILAR ITEMS BY 24” MINIMUM AS ILLUSTRATED BY THIS DIAGRAM.

FOR PURPOSES OF THESE RULES, ITEMS SHOWN LOCATED APPROXIMATELY WITHIN 4 FEET OF PLANE CHANGE ARE CONSIDERED TO BE ADJACENT TO CHANGE IN PLANE.

RULE 6

WHEN NOT DIMENSIONED AND LOCATED ADJACENT TO CHANGE IN WALL DIRECTION

NOTES:
1) TYP RULES FOR DETERMINING MOUNTING HEIGHTS, LOCATIONS, & CONFIGURATIONS
2) 2009 ANSI A117.1