

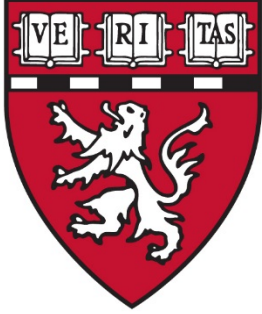


HARVARD
MEDICAL SCHOOL

FACILITIES
DESIGN
STANDARD

Construction/Renovations

October 31, 2016



HARVARD

MEDICAL SCHOOL

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01 – Energy & Environment

1. Summary

- a. Harvard Medical School is regularly pursuing projects which enhance the usability of campus facilities as their needs change over time. The intent of the document is to seek all means necessary to reduce the impact these changes have on energy consumption, Green House Gas (GHG) emissions, the local environment and utility infrastructure. This document outlines both requirements and best practices for building design and selection of the right building components with the intent of providing long term sustainable benefits. The focus is on energy efficiency and cooling load reductions but with that comes reduced operating and maintenance costs.

2. Related Sections

- a. Division 22 – Plumbing
- b. Division 23 – HVAC
- c. Division 26 – Electrical

3. Referenced Publications

- a. Harvard Green Building Standards
- b. Harvard Green Building Standards - Deliverables Checklist
- c. Massachusetts State Building Code (780 CMR)
- d. Massachusetts Stretch Energy Code (780 CMR Appendix 115.AA)
- e. International Energy Conservation Code (IECC)
- f. Energy Standard for Buildings Except Low Rise Residential Buildings (ASHRAE 90.1)
- g. Ventilation for Acceptable Indoor Air Quality (ASHRAE 61.2)

4. Objectives

- a. Harvard University and Harvard Medical School are internationally recognized leaders in green building and are committed to sustainability by minimizing energy consumption and GHG emissions. Every building project, whether it is a replacement of aging components, an existing building fit-out, a full building renovation or new construction project the project manager shall follow the standards as they are laid out with the following goals:



- i. Reducing energy consumption
- ii. Reduce cooling load
- iii. Reduced life-cycle cost
- iv. Reduce operating and maintenance cost
- v. Increase building livability.

5. Deliverables

- a. The Massachusetts Energy and Stretch Energy codes allows for compliance with either IEEC or ASHRAE 90.1 both with Massachusetts amendments. It should be set forth as to which code compliance path is being pursued for all design disciplines to follow and adhere to it for the life of the project. For all projects, project managers shall present documents for review at each design phase completion identifying all energy consuming components and their performance as it relates to current code compliance. Energy consuming components should be selected which exceed the selected energy code by a minimum of 18%.
- b. Provided alternates for energy consuming components which exceed current code compliance by at least 25%.
- c. Provide a list of components for review which do not directly consume energy but impact energy consumption such as exterior walls, roofs, glazing and controls and identify the code compliance performance. Provide alternates which exceed current code compliance focusing on reducing cooling loads.
- d. Identify and provide a list of eligible components and the potential incentives and rebates available.
- e. All capital projects (\$100,000+) shall meet requirements detailed in the Harvard Green Building Standards document per the project's Tier level. Additionally, project managers shall complete and submit for review the appropriate Harvard Green Building Standards – Deliverable Checklists applicable to the project's Tier level. Table 1 identifies the required deliverables for each Tier level.
 - i. Integrated design requires the project team to collaborate through design charrettes. All team members are required to meet and discuss sustainability goals and determine how to achieve them. The team also needs to ensure the goals remain in the project all the way through to completion of the project.
 - ii. Life-cycle costing is performed on the building components to ensure over the expected component life time that it won't cost more than another comparable component. Life cycle costing considers initial construction costs, operation and



maintenance costs, utility costs and incentive/ rebate costs over the expected component life.

- iii. Energy modeling is performed to estimate building energy consumption of proposed building designs and compare it to a code compliant building design. This is generally used for larger building renovations or new constructions but can also be used for smaller scale projects.
- iv. Prescriptive requirements are identified in the appropriate section of the selected code. Sections refer to envelope, mechanical, lighting water heaters and controls.
- v. Metering and ongoing verification is a way to better understand where building energy is being consumed. The building utility meter identifies the total energy consumed at the building but not specifically by what end use (lighting, fans, pumps). Meters installed per the requirements of the Harvard Green Building Standards document allows for verification that the building is operating as intended.
- vi. Closeout documentation/ OEM readiness ensures that all operation and maintenance documentation applicable to new building components is provided for use by building managers. This reference material is critical to maintain proper component operation or to address a malfunction.

Table 1

Tier	Integrated Design	Life Cycle Costing	Energy Modeling/ GHG Calculations	Prescriptive Requirements	Metering and Ongoing Verification	Closeout Documentation/ OEM Readiness
1	YES	YES	YES	YES	YES	YES
2A	YES	YES	OPTIONAL	YES	YES	YES
2B	YES	YES	OPTIONAL	YES	YES	YES
2C	OPTIONAL	YES	OPTIONAL	YES	YES	YES
3	OPTIONAL	OPTIONAL	OPTIONAL	YES	YES	YES
4	OPTIONAL	NA	NA	NA	NA	NA

6. Minimum Design Criteria for All Projects

- a. For all new construction, renovation and replacement projects submitting building permits shall have energy consuming components which exceed current code



compliance performance by 18% at minimum. This applies to such components as mechanical equipment and lighting.

- b. For all new construction, renovation and replacement projects submitting building permits shall have components which do not directly consume energy but impact energy consumption exceed current code compliance.
 - c. Life cycle cost analysis shall be completed on all components to aid in the selection of the component which provides the greatest energy consumption savings and the lowest life cycle cost.
 - d. Whole building energy modeling energy reduction percentages shall adhere to the Harvard Green Building Standards document.
7. Commissioning
- a. All new work shall be fully commissioned to ensure as-designed operation. All new components shall be tested including control points, programming, and calibration of field devices shall be completed. Third-party commissioning eliminates conflicts of interest and provides the highest value to Harvard and is recommended.
 - b. Commissioning team shall be involved throughout the project including the planning, designing and constructing stages.
8. Net-Zero
- a. Test the feasibility of pursuing net zero for Tier 1 projects. Net zero is not required but it must be demonstrated the feasibility was evaluated as directed in the Harvard Green Building Standards document.
9. General Design Guidelines
- a. Minimize building loads especially those which reduce cooling such as at the exterior building envelope (walls, roofs, glazing), interior loads such as electrical equipment, computer, kitchen equipment, and lighting.
 - b. Select low-flow domestic water fixtures.
 - c. Select heating, ventilating and air conditioning equipment which optimizes efficiency. This includes, air handling equipment, air conditioning units, pumps, chillers, boilers and hot water heaters.
 - d. Select building elements that can be controlled to operate at an occupied setting and at an unoccupied setting to allow for shut down or setbacks for spaces when not in use.
 - e. Design ventilation to the requirements of ASHRAE 62.1.



- f. Study the viability of providing renewable energy (Photo Voltaic, solar hot water, wind).
- g. Study the viability of providing combined heat and power.
- h. Perform continuous commissioning to ensure optimal ongoing building performance.

10. Component Design Guidelines

- a. Reference the appropriate standard for the following components:
 - i. Air Handling Units
 - ii. Motors and Electrical Systems
 - iii. Chiller System
 - iv. Controls
 - v. General Temperature
 - vi. Lighting Systems
 - vii. Building Envelope
 - viii. Comfort Heating
 - ix. Plumbing Equipment and System

11. Incentives and Rebates

- a. Incentives and rebates provide funding to help offset the increased cost of installing higher performance building components. Incentives and rebates reduce the simple payback that would otherwise make selecting higher performance components more difficult.
- b. Incentives and rebates can come from local, state and federal funding sources in the form of direct payment or through tax breaks. Utility companies offer the most abundant and robust programs. All options shall be investigated.
- c. All projects shall pursue utility rebates and incentives on any energy consuming components or components which don't directly consume energy but do impact energy consumption indirectly.
- d. Utility personnel shall be notified of any potential projects early in the design preferably during the schematic design phase. This will help to maximize the level of participation the utility can deliver. This would also be a good opportunity to make design changes that would allow for greater participation in the available utility programs



- e. Project managers shall review component selection at each design phase completion to ensure that all selections are meeting performance goals set forth at the beginning of the project and will be eligible to receive incentives and rebates.

End of Section



01 9113 – General Commissioning Requirements

1. Description

- a. If this project is to be LEED certified, than it must follow the Harvard University Green Building Standards.
- b. Commissioning intent is to follow the guidelines of this HMS Standard and Construction Document Specifications.
- c. Contract documents shall also include:
 - i. Divisions of the specifications with special attention to:
 1. See Division 01 for General Conditions.
 2. See Division 21 for Fire Protection
 3. See Division 22 for Plumbing.
 4. See Division 23 for HVAC
 5. See Division 25 for Buildings Building Automation System (BAS)
 6. See Division 26 for Electrical.

2. Commissioning Process: Pre-Design and Design Phase

- a. Establish the owners commissioning team which should consist of the project manager and appointed facilities staff.
- b. Perform a review of the Owner’s Project Requirements (OPR).
- c. Perform a review of the Basis of Design (BOD) compared to the OPR.
- d. For design review with comments requirements, please see the Flow Chart in Section 6.a of this Commissioning Standard.
- e. Commissioning specifications please refer to the Flow Chart in Section 6.a of this Commissioning Standard.
- f. Develop a project specific preliminary commissioning plan.
- g. Perform an evaluation of the HVAC and BAS in the existing space and support areas around the space prior to the construction demolition phase starts



3. Commissioning Process: Construction Phase

- a. Develop project specific construction checklists
- b. Perform a review of the contractor submittals for they systems to be commissioned
- c. Conduct a commissioning team kick-off meeting and maintain continuity throughout the duration of the project through additional meetings, produce and issue meeting minutes.
- d. Perform inspections of the project systems to be commissioned periodically throughout the construction process and document through a field report to the owner and commissioning team
- e. Develop the functional performance testing scripts
- f. Update the commissioning plan in preparation for the functional performance testing

4. Commissioning Process: Commissioning Phase

- a. Perform functional performance verification
 - i. Static commissioning of the components
 - ii. Dynamic commissioning of the sequences of operations
- b. Issue weekly status reports for the systems commissioned
- c. Issue and maintain a corrective actions log sheet
- d. Perform a detailed review of the programmed sequences of operations and graphics for the systems and areas that are commissioned.
 - i. Each review should have screen captures to document in the final commissioning report.
 - ii. Each review should have 24 hour rends/graphs to confirm equipment operation (critical System points).
 - iii. Each review should have a copy of any custom Powers Process Control Language (PPCL) code written for equipment operation.
- e. Issue the final commissioning Pre-occupancy Report.

5. Commissioning Process: Acceptance Phase



- a. Perform a final evaluation of the supporting areas around the project to confirm that the current project did not alter their operations
 - b. Verify that all open action items have been answered
 - c. Verify that owner training had been completed
 - d. Issue a final commissioning report
 - e. Review and collect final O&M manuals for the systems commissioned.
 - f. Perform a 10 month follow-up and review of the systems commissioned
 - g. Perform deferred seasonal testing (if required)
6. Commissioning Standard Table
- a. Table to be inserted at a later date.



21 0510 – Existing Fire Protection Systems Description

The existing system descriptions below are based on the best information available as of September 30, 2016. The designer shall verify on site all existing fire protection systems, equipment, infrastructure, and all conditions which affect the design of new fire protection system, and extensions and/or modifications to existing fire protection systems. The designer shall also refer to the most current existing fire protection systems information, documentation and fire pump test reports provided by Harvard Medical School, with the responsibility to verify all applicable existing systems and conditions as noted above.

1. Armenise Building

- a. Incoming Water Service or Source, and General information: The Armenise building is a 6-story building, provided throughout with Class III automatic wet pipe standpipe systems and automatic sprinkler systems. The Armenise fire protection systems are supplied by the Alpert building fire pump. A 6" express feed for Armenise extends from Alpert, across the basement. The Modell building sprinkler systems are fed from connections to the Armenise combination standpipes. Two 6" combination standpipe risers and two 4" combination standpipe risers are located at the (4) egress stairs, and they supply the wet sprinkler systems at each floor.
- b. Fire Pump: Fire protection systems are supplied from the existing fire pump located within the Alpert Building basement. The fire pump is an electric horizontal split case type and rated for 1500 GPM @ 95 PSIG boost and is designed to serve the entire sprinkler and standpipe systems of the Modell, Alpert and Armenise buildings
- c. Other Systems: A pre-action sprinkler system also exists at this building.

2. Building C

- a. Incoming Water Service or Source, and General Information: Building C is a 6-story building provided throughout with automatic wet pipe standpipe systems and automatic sprinkler systems. The Building C fire protection systems are supplied by a dedicated fire pump located at the basement, which also supplies the fire protection systems at the adjacent Gordon Hall. An 8" fire protection water service enters the Basement and is piped through an 8" double check valve assembly. The fire main then supplies the fire pump at the basement. The fire pump discharge main extends to a 6" wet alarm check valve and becomes the fire protection distribution main. The 6" distribution main extends across the ceiling of the Basement to serve the (2) 6" combination standpipes at the (2) egress stairs and the (2) 4" dedicated standpipes at the remote ends of the floor plan. The sprinkler systems are fed from the combination risers at each floor.



- b. Fire Pump: The existing sprinkler and standpipe systems are supplied from an existing fire pump located at the basement. Fire pump is rated at 1000 gpm at 50 psig boost. This fire pump also supplies the fire protection systems at Gordon Hall.
 - c. Other Systems: A double interlock pre-action sprinkler system also exists at this building, at the first floor.
3. Countway Library
- a. Incoming Water Service or Source, and General information: The HMS Countway Library is an existing 6-story building currently provided throughout with an automatic fire sprinkler system and automatic standpipe system. A 6" fire protection water service enters the lower level fire pump room from the north and becomes the suction main for the fire pump. A 6" double check valve is located in the fire pump room. Two 6" combination standpipe risers are located at the (2) egress stairs, and they supply the wet sprinkler systems at each floor. A common 6" standpipe /sprinkler systems distribution main extends across the lower level to supply the standpipes.
 - b. Fire Pump: The existing sprinkler and standpipe systems are supplied from an existing fire pump located at the lower level. Fire pump is rated at 750 gpm at 85 psig boost.
 - c. Other Systems: An Inergen gaseous fire suppression system is located at the roof.
4. Goldenson Building
- a. Incoming Water Service or Source, and General information: The Goldenson building is a 6-story building provided throughout with Class III automatic wet pipe standpipe systems and automatic sprinkler systems. The Goldenson fire protection systems are supplied by the Alpert building fire pump. A 6" express feed for Goldenson extends from Alpert, across the basement. Standpipe risers are located within the (3) egress stairs. Two of the standpipes are 6" combination risers supplying the wet sprinkler systems at each floor. One of the standpipes is a dedicated standpipe serving fire department valves only.
 - b. Fire Pump: Fire protection systems are supplied from the existing fire pump located within the Alpert Building basement. The fire pump is an electric horizontal split case type and rated for 1500 GPM @ 95 PSIG boost and is designed to serve the entire sprinkler and standpipe systems of the Modell, Goldenson, Alpert and Armenise buildings
 - c. Other Systems: None.
5. Gordon Hall
- a. Incoming Water Service or Source, and General information: The fire protection systems at Gordon Hall are supplied by the fire pump at Building C. A 6" distribution



main extends across the ceiling of the Basement to serve the (3) combination standpipes at the (2) egress stairs and (1) at the west end of the floor plan. The sprinkler systems are fed from the combination risers at each floor. Two standpipe risers, the east and west risers, are 4", and the central riser is 6".

- b. Fire Pump: Fire protection systems are supplied from the fire pump located within the Building C Basement. The fire pump is an electric horizontal split case type and rated for 1000 GPM @ 50 PSIG boost
- c. Other Systems: An FM200 total flooding gaseous fire suppression system is located at the 5TH floor IT Data Center Room:

6. Harvard Institutes of Medicine (HIM)

- a. The HIM building is 12 stories above grade including a mechanical penthouse and two basement levels below grade. Automatic sprinkler protection is provided throughout the entire existing building. A 10" Fire Service enters the Basement and is piped through an 8" double check valve assembly. The fire main then supplies the fire pump at the basement. The fire pump discharge main extends to an 8" wet alarm check valve and becomes the fire protection distribution main. The discharge main also feeds two dry valves at the fire pump room. The dry valves serve the dry sprinkler system and dry standpipe at the garage. The 8" distribution main extends across the ceiling of the Basement to serve all combination standpipes. The existing Class I combination sprinkler and standpipe system distribution feeds standpipes located in the (4) egress stairs and the existing bridge connecting to the adjacent New Research Building (NRB). Combination standpipes are located in (2) of the stairs, and the other (2) stairs are provided with dedicated standpipes. The combination standpipes dual-feed the sprinkler systems at each floor. Fire department connections are provided at the Basement to serve all systems within the building.
- b. Fire Pump: The existing sprinkler and standpipe systems are supplied from an existing fire pump located at the basement. Fire pump is rated at 1000 GPM at 120 PSIG boost.
- c. Other Systems: None

7. Laboratory for Human Reproduction and Reproductive Biology (LHRRB)

- a. The LHRRB is an existing 6-story building currently provided throughout with an automatic fire sprinkler system and automatic standpipe system. Automatic sprinkler protection is provided throughout the entire existing building. An existing 6" Fire Service enters the Basement and is piped through a 6" double check valve assembly. The fire main then supplies the fire pump at the basement. The fire pump discharge main extends to a 6" wet alarm check valve and becomes the fire protection distribution main. The 6" distribution main extends across the ceiling of the Basement to serve the (2) combination standpipes located in the (2) egress and (1) dedicated standpipe at the midpoint of the central corridor. The combination standpipes dual-feed the sprinkler



systems at each floor. Fire department connections are provided at the Basement to serve all systems within the building.

- b. The existing sprinkler and standpipe systems are supplied from an existing vertical fire pump located at the basement. Fire pump is rated at 500 gpm at 85 psig boost.
- c. Other Systems: An Inergen gaseous fire suppression system is located at the 6TH floor IT room.

8. New Research Building (NRB)

- a. Incoming Fire Service or Source, and General information: The NRB is an existing 11-story high-rise building, which is provided throughout with an automatic fire sprinkler system and automatic standpipe system. The existing sprinkler and standpipe systems are supplied from an existing electric driven fire pump at the Ground Floor of the NRB. An 8" private fire protection water main enters the Basement off the municipal main in Blackfan Circle, is piped through an 8" double check valve assembly, and serves as the suction supply for this fire pump. The fire pump discharge main extends to an 8" wet alarm check valve, and two 4" dry valves at the fire pump room. The dry valves serve the dry sprinkler systems at the two below grade parking levels. The fire pump discharge extends across the ceiling of the Ground Floor to serve all combination standpipes. The Class I combination sprinkler standpipe system feeds standpipes located in the (3) egress stairs and the existing bridge connecting to the adjacent Harvard Institute of Medicine (HIM) building. The 2½" fire department hose valves are provided at the floor level landings of egress stairs. Test/drain risers are provided in the stairs adjacent to the combination sprinkler/standpipe risers. Automatic sprinkler protection is provided throughout the entire building. Floor control valve assemblies are located at the floor level of the Northeast and Southwest egress stairs and dual-feed the sprinkler systems at each floor. Fire department connections are provided at the First Floor level to serve all systems within the building.
- b. Fire Pump: The existing NRB fire pump is a horizontal split case, electric driven fire pump, with a rated capacity of 1000 GPM at 180 PSIG boost.
- c. Other Systems: Two Ansul dry chemical suppression systems are located at the kitchen.

9. Seeley G. Mudd

- a. Incoming Fire Service or Source, and General information: The HMS Seeley Mudd is an existing 6-story building currently provided throughout with an automatic fire sprinkler system and automatic standpipe system. There is a fire pump at the basement. There are two 6" fire protection water service mains serving this building, extending from the municipal water system. One of the 6" mains feeds a dedicated alarm valve for the basement sprinkler system, not supplied from the fire pump. The other 6" main is the suction for the fire pump, which serves the standpipe system and all sprinkler systems above the basement. A 6" fire protection distribution main extends across the



basement to serve the standpipes, one of which is a combined standpipe. Sprinkler systems at each floor above the basement are fed from the combination standpipe.

- b. Fire Pump: The existing sprinkler and standpipe systems are supplied from an existing fire pump located at the basement. Fire pump is rated at 500 gpm at 90 psig boost.
- c. Other Systems: None

10. Tosteson Medical Education Center (TMEC)

- a. Incoming Fire Service or Source, and General information: The HMS Tosteson Medical Education Center (TMEC) Building is an existing 5-story building currently provided throughout with an automatic fire sprinkler system and automatic standpipe system. The combination standpipe system is supplied from an 8" fire protection main connected to an existing fire pump, located at the basement level. The fire pump is supplied from an 8" fire protection water service connected to the municipal water system. The existing standpipe system includes 2-1/2" fire department hose valves in the stairwells.
- b. Fire Pump: The existing sprinkler and standpipe systems are supplied from an existing fire pump located at the basement. The fire pump is rated at 1500 GPM at 60 PSIG boost, and is an electric-driven horizontal split case unit.
- c. Other Systems: An Inergen gaseous fire suppression system is located at the basement.

11. Vanderbilt Hall

- a. Incoming Fire Service or Source, and General information: Vanderbilt Hall is an existing 7-story building currently provided throughout with an automatic fire sprinkler system and automatic standpipe system. Most of the building sections are 4 and 5 story, but a small portion of the north wing includes a 6th floor and penthouse. The building is arranged as rectangular loop with a center exterior courtyard/tennis court. The combination standpipe system is supplied from an 8" fire protection main connected to an existing fire pump, located at the basement level. The fire pump is supplied from an 8" fire protection water service connected to the municipal water system. The 8" fire protection main distribution extends down to the sub-basement, forming a perimeter loop distribution main, to supply all standpipe risers, most of which are 4" standpipes, with the exception of one 6" standpipe at the northwest area. Original system design intent appears to be designing to a remote standpipe demand pressure of 65 PSIG.
- b. Fire Pump: The existing sprinkler and standpipe systems are supplied from an existing fire pump located at the basement. The fire pump is rated at 1000 GPM at 75 PSIG boost, and is an electric-driven horizontal split case unit.
- c. Other Systems: None.



12. Warren Alpert Building

- a. Incoming Fire Service or Source, and General information: The Warren Alpert Building is an existing 5-story high-rise building, which is currently provided throughout with an automatic fire sprinkler system and automatic standpipe system. The existing sprinkler and standpipe systems are supplied from an existing electric driven fire pump at the basement of the Alpert Building. An 8" private fire protection water main, connected to a municipal water main in Longwood Ave., serves as the suction supply for this fire pump. Downstream of the existing fire pump, main piping distribution extends to alarm valves for various buildings and areas. Goldenson, Modell and Armenise Buildings' fire protection systems are supplied by the Alpert fire pump. The 6" main distribution for the Alpert Building extends further downstream of a dedicated 6" alarm valve to feed two 6" standpipes at the 2 egress stairs. These standpipes extend up through the building serving sprinkler systems zoned independently by floor. Typically, these standpipes feed automatic wet sprinkler systems, which are dual-fed with a floor control valve assembly at each standpipe in the stairwell floor landings.
- b. Fire Pump: The existing Alpert Building fire pump is a horizontal split case, electric driven fire pump, with a rated capacity of 1500 GPM at 95 PSIG boost. . It is located at the basement.
- c. Other Systems
 - i. This building also includes six (6) dry sprinkler systems serving the garage and loading dock. A pre-action sprinkler system is located at the penthouse.
 - ii. Due to the proximity of the Modell addition to the adjacent Alpert Building, and potential fire exposure from the addition to the Alpert, an exposure protection deluge sprinkler system is provided at the west exterior wall of the Alpert Building. The deluge sprinklers are located at the tops of Alpert windows at Levels 2, and 3. A Protectowire linear heat detection system mounted to the exterior piping initiates the deluge valve release upon detection of temperature rise above 280F. The deluge system control/alarm/release panel is a Protectowire type and reports back to the building fire alarm system.

13. 158 Longwood Avenue

- a. The 158 Longwood Avenue building is currently not provided with any fire protection systems.

14. 160-164 Longwood Avenue

- a. Incoming Water Service or Source, and General information: The 160-164 Longwood building is a 4-story building provided with an automatic wet sprinkler system at the basement only. The remainder of this building is not currently provided with any fire



protection systems. The 160-164 Longwood sprinkler system is supplied by the 641 Huntington building fire pump.

- b. Fire Pump: Fire protection systems are supplied from the existing fire pump located within the 641 Huntington Building basement. The fire pump is an electric horizontal split case type and rated for 450 GPM @ 50 PSIG boost.
- c. Other Systems: None

15. 180 Longwood Avenue

- a. Incoming Water Service or Source, and General information: The 180 Longwood building is a 3-story building provided with an automatic wet sprinkler system at the basement, and a partial sprinkler system at the 1ST floor only. The remainder of this building is not currently provided with any fire protection systems. The 180 Longwood sprinkler system is supplied by a direct connection to the municipal water main in Longwood Ave.
- b. Fire Pump: None; this building is supplied by municipal water system pressure only.
- c. Other Systems: A total flooding Novec 1230 gaseous fire suppression system is located at the Basement to protect the IT Room 031.

16. 641 Huntington Avenue

- a. Incoming Fire Service or Source, and General information: The 641 Huntington Ave building is a 4 story building with a penthouse, currently provided throughout with an automatic fire sprinkler system and manual standpipe system. The sprinkler and standpipe systems are supplied from a 6" fire protection main connected to an existing fire pump, located at the basement level. The fire pump is supplied from city water service. A 6" combination sprinkler and standpipe distribution main extends from the fire pump room to serve the 4" standpipe riser at the egress stair. A second express 2-1/2" fire protection distribution main extends from the fire pump to the sprinkler system at 160-164 Longwood Ave. There does not appear to be a fire dept. inlet connection.
- b. Fire Pump: The existing sprinkler and standpipe systems are supplied from an existing fire pump located at the basement. Fire pump is rated at 450 GPM at 50 PSIG boost.

17. School of Dental Medicine

- a. The School of Dental Medicine building is currently not provided with any fire protection systems.

18. Research and Education Building (REB)

- a. Incoming Fire Service or Source, and General information: The REB is an existing high rise 6-story building, 5 occupied floors, plus a mechanical penthouse, currently provided



throughout with an automatic fire sprinkler system and automatic standpipe system. There is a fire pump at the basement. There is an 8” fire protection water service main serving this building, extending from the municipal water system. The 8” main is the suction for the fire pump, which serves the standpipe system, and all wet, dry, and deluge sprinkler systems. A 6” fire protection distribution main extends from the fire pump discharge, across the basement, to serve the standpipes, both of which are combined standpipes. Wet sprinkler systems at each floor are fed from both combination standpipes. A dry sprinkler system is located at the basement loading dock, receiving and associated areas subject to freezing. The dry valve is located at the Basement West Mech room. A dry sprinkler system is located at the penthouse emergency electric, generator and associated areas subject to freezing. This dry valve is located at the Penthouse Southwest Mech area.

- b. Fire Pump: The existing sprinkler and standpipe systems are supplied from an existing fire pump located at the basement. Fire pump is rated at 1000 gpm at 130 psig boost. A master pressure reducing valve is provided immediately downstream of the fire pump discharge to limit system pressures to 165 PSIG or less.
- c. Other Systems: None
 - i. Due to the proximity of the REB to the adjacent Harvard School of Public Health Building, a deluge exposure protection system is located at the exterior of the Penthouse and 5TH floor.

19. Jeffrey Modell Building

- a. Incoming Water Service or Source, and General information: The Jeffrey Modell Immunology Center is a 2- story addition to the existing 6-story Armenise Building. Existing Class III automatic wet pipe standpipe systems are provided in both the Alpert and Armenise buildings, and also serve the Modell building. The Modell building is provided throughout with wet automatic sprinkler systems connected to the combination standpipes at the Armenise building.
- b. Fire Pump: Fire protection systems are supplied from the existing fire pump located within the Alpert Building basement. The fire pump is an electric horizontal split case type and rated for 1500 GPM @ 95 PSIG boost and is designed to serve the entire sprinkler and standpipe systems of the Modell, Goldenson, Alpert and Armenise buildings.
- c. Other Systems: Refer to Warren Alpert Building description of the exposure protection sprinkler system.

21 1000 – Fire Protection Systems



1. Design Statement

- a. The new and/or modified fire protection systems shall have the following characteristics
 - i. Occupant and building safety.
 - ii. No adverse effect on public water supply and existing infrastructure. If any renovation, addition, or system modification creates demands beyond the capacity of existing supply or system infrastructure, the designer shall immediately bring this information to the attention of the owner's project manager, in writing, for further direction.
 - iii. Flexibility for future changes.
 - iv. Durability.
 - v. Ease of maintenance.
 - vi. Reliability and redundancy
- b. Every effort will be made to design, layout and install equipment in locations which will tend to encourage routine preventive maintenance by providing easy access for maintenance personnel. Manual isolation valves will be provided to enable servicing, expansion of, renovation or construction of any part of the existing facility without unscheduled interruption of services in adjacent areas
- c. All systems and equipment shall be designed in accordance with Massachusetts Building Code, recommendations of the National Fire Protection Association (NFPA), National Electrical Code (NEC) and the Owner's insurance underwriter
- d. The designer shall provide design documents which direct all involved contractors to provide fire protection systems, and all associated equipment and components which achieve the standards contained in this document.

2. Codes, Standards and References

- a. All materials and workmanship shall comply with all applicable Codes, Specifications, Local and State Ordinances, Industry Standards and Utility Company Regulations, latest editions.
- b. In case of difference between Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations and the Contract Documents, the Fire Protection Contractor, as applicable, shall promptly notify the Owner's Project Manager in writing of any such difference.
- c. In case of conflict between the Contract Documents and the requirements of any Code or Authorities having jurisdiction, the most stringent requirements of the



aforementioned shall govern for budgetary purposes. However, no work will proceed until the Architect determines the correct method of installation.

- d. Applicable Codes and Standards shall include all State Laws, Local Ordinances, Utility Company Regulations and the applicable requirements of the following accepted Codes and Standards, without limiting the number, as follows:
- e. National Fire Protection Association (NFPA) Standards Nos: 13, 14, 20, 24, 25, 45, 70, 72 and NFPA 101, Life Safety Code

3. Design Criteria

- a. Combination standpipe/sprinkler systems and all components, piping, valves and head location, ratings, etc., shall be designed in accordance with NFPA 13, 14, 20, 24, State Building Code and Owner’s Insurance Company and other applicable NFPA standards governing the installation of underground fire mains, alarm valves, system drains, fire pump, etc.
- b. Standpipe systems, and modifications to existing standpipe systems, for high rise buildings shall be designed to provide 100 PSIG residual pressure at the top-most remote flowing hose valve connection, in conformance with NFPA 14 and applicable state building code.
- c. Hydraulic calculations for both standpipes and sprinkler systems shall be designed to include a 10 PSIG safety margin.
- d. Sprinkler system design shall be based on the following information in Table 1 below and in accordance with the Owner’s Insurance Company requirements. Sprinkler systems shall be provided throughout the building or renovated area, as applicable to the project scope, designed in accordance with the following NFPA 13 hazard classifications, and shall be hydraulically calculated to provide the following specified densities:


 HARVARD MEDICAL SCHOOL	FACILITIES DESIGN STANDARD CONSTRUCTION/RENOVATION	SOP #: HMS_DS_FIRE PROTECTION_.01
TITLE: Division 21 Fire Protection		REVISION: October 14, 2016

Table 1

AREA	NFPA 13 OCCUPANCY HAZARD	SPRINKLER SYSTEM HYDRAULIC CRITERIA	MAXIMUM PROTECTION AREA PER SPRINKLER	SYSTEM TYPE	NOTES
Offices, lounges, conference rooms, classrooms, separated dining areas, auditoriums, lobbies, toilet rooms, corridors, common areas, patient areas, etc.	Light	0.10 GPM/FT ² over most remote 1,500 FT ² + 250 GPM hose demand at municipal water source.	196 FT ² in areas with finished ACT ceiling tiles. 225 FT ² in areas with finished GWB ceilings.	Wet	Dining areas NOT separated from kitchens and serveries shall utilize Ordinary Hazard Group 1 criteria.
Laboratories, animal areas, support and adjoining spaces, and associated work, preparation and research areas.	Ordinary Hazard Group 1 for Laboratory Classes C and D per NFPA 45	0.15 GPM/FT ² over most remote 1,500 FT ² +250 GPM hose demand at municipal water source.	130 FT ²	Wet	The designer shall consult with the architect, code consultant and owner's project manager to determine the NFPA 45 lab class.
	Ordinary Hazard Group 2 for Laboratory Classes A and B per NFPA 45	0.20 GPM/FT ² over most remote 1,500 FT ² +250 GPM hose demand at municipal water source			



AREA	NFPA 13 OCCUPANCY HAZARD	SPRINKLER SYSTEM HYDRAULIC CRITERIA	MAXIMUM PROTECTION AREA PER SPRINKLER	SYSTEM TYPE	NOTES
Mechanical, electrical, Classes I to IV commodities storage, workshop and utility areas, glasswash, cagewash.	Ordinary Hazard Group 2	0.20 GPM/FT ² over most remote 1,500 FT ² +250 GPM hose demand at municipal water source.	130 FT ²	Wet	Storage less than 10 FT in height, and NOT rack storage. For other storage types, refer to NFPA 13 for specific criteria.
Kitchen and servery areas,	Ordinary Hazard Group 1	0.15 GPM/FT ² over most remote 1,500 FT ² +250 GPM hose demand at municipal water source.	130 FT ²	Wet	
Parking garages.	Ordinary Hazard Group 1	0.15 GPM/FT ² over most remote 1,950 FT ² +250 GPM hose demand at municipal water source.	130 FT ²	Dry	
Areas noted above, if subject to freezing.	Classifications as noted above.	Density as noted above, with 30% increase in area. Same hose demand.	130 FT ²	Dry	



AREA	NFPA 13 OCCUPANCY HAZARD	SPRINKLER SYSTEM HYDRAULIC CRITERIA	MAXIMUM PROTECTION AREA PER SPRINKLER	SYSTEM TYPE	NOTES
Specialty areas, high-value assets, server rooms, microscope rooms, archives, magnet areas, CT scan and other imaging areas.	Classifications as noted above for laboratories, research areas, etc.	Densities as noted above for laboratories, research areas, etc.	130FT ²	Wet	<p>1.The designer shall consult with the owner’s project manager to determine whether or not the owner may desire to utilize any special suppression systems, such as pre-action sprinkler systems, Inergen, Novec, FM-200, etc.</p> <p>2. The designer shall consult with the architect, code consultant and owner’s project manager to determine the NFPA 45 lab class.</p>



4. Hydraulic Calculations

- a. The designer shall provide a hydraulically designed system in complete accordance with and as defined in applicable National Fire Protection Standards.
- b. Verification of Hydraulic Information:
 - i. The designer shall obtain current hydrant flow test or existing fire pump flow test information, and shall direct the contractor to perform hydrant flow tests, to establish water supply availability.
 - ii. Water supply information shall be provided on in design documentation.
 - iii. The designer shall confirm that hazard classifications/density requirements conform with the owner's insurance underwriter's requirements and those of other authorities having jurisdiction.
 - iv. The designer shall confirm the presence or absence of existing fire pumps and obtain current test data for same.
 - v. The designer shall make necessary field measurements of the existing fire protection system if applicable.
 - vi. The designer must obtain current pump test results or request a new fire pump flow test in accordance with NFPA 20 to establish the performance of the existing fire pump.
- c. Design drawings and hydraulic calculations shall clearly describe and graph all water supply information.
- d. All calculations shall assume 10 PSI safety margin to allow for deterioration in static and residual pressures in the hydrant flow test and fire pump flow test results.
- e. Velocity shall not exceed 20 FPS.
- f. Hydraulic calculations shall include the hydraulically most remote area for each hazard classification/density requirements as noted on the contract documents.
- g. If combination risers are shown interconnected with sprinkler piping, hydraulic calculations shall show the remote area being supplied solely from the hydraulically most remote combination riser.
- h. If new work is to be connected to existing piping the designer shall verify that the existing piping can support demands generated by the hydraulic calculations.



- i. Hydraulic calculations submitted to owner’s project manager and architect shall be easily readable, in clear PDF format, not scanned. All hydraulic reference points included in calculations shall be represented by corresponding and matching hydraulic reference points on drawings. Hydraulic reference points on drawings shall not be obscured or overwrite other graphics or text, nor be overwritten by other graphics or text. The designer shall provide the owner’s project manager with any and all software needed in order to properly and completely view the hydraulic calculations and accompanying drawings. A site utility plan and riser diagram with hydraulic reference points shall also be included. The designer shall direct the contractor to do the same.
 - j. The engineer of record shall review existing fire protection system hydraulic design placards, and identify existing hydraulic demands. If any renovation, addition or system modification work increases the hydraulic demands, new hydraulic design information placards, indicating the new increased hydraulic design demand information, shall be provided by the contractor.
5. Earthquake Protection and Seismic Restraints
- a. The designer shall include direction in design documentation that the fire protection contractor must provide all necessary design and materials for seismic restraint and protection of piping and devices against damage where subject to earthquake as required by applicable code and NFPA 13, for the entire fire protection system within the building or renovation area. All isolation and seismic devices shall be the product of a single manufacturer. Isolation materials and seismic restraints shall be as manufactured by Mason Industries, Tolco or approved equal.
 - b. The designer shall provide direction in design documentation that the fire protection contractor must include the design, furnishing and installation of all restraint devices and systems as may be required for the fire protection system, and the following specific submittal items.
 - c. Submittals shall include descriptive data for all products and materials, including the following:
 - i. Catalog cuts and data sheets for the specific isolators, restrains and all other items to be utilized.
 - ii. Details of methods of sleeving, fire protection, smoke proofing and isolation for pipes penetrating walls and slabs.
 - iii. Specific details of seismic restraints and anchors, including number, size and locations for each piece of equipment.
 - iv. Calculations to support seismic restraint designs.



- v. All calculations, details and other submittal materials shall be sealed and signed by a Structural or Civil Engineer registered in the state and qualified to perform seismic design calculations.
- vi. A seismic design liability insurance certificate that must accompany all submittals.

6. Temporary Protection, Impairments and Safeguarding

- a. The designer shall provide the following direction in design documentation for implementation by the fire protection contractor, and general contractor/construction manager:
 - i. Safeguarding of the building during demolition, alteration and construction shall be a joint cooperative effort involving the entire project team, and primarily the fire protection contractor, the fire alarm contractor, the general contractor/construction manager, owner and all authorities having jurisdiction. The fire protection contractor and fire alarm contractor shall coordinate with any and all parties as appropriate in order to achieve proper safeguarding as described in the project documents.
 - ii. The contractors shall ensure proper building protection and safeguarding at all times during demolition, alteration, and construction in complete compliance with all applicable codes, regulations and standards.
 - iii. During times when the existing building fire protection systems are impaired, the contractors shall provide appropriate safeguarding of the renovation work area, and temporary heat detection or adequate alternate protection throughout the space, as coordinated with, and approved by, the tenant's and owner's fire prevention program manager, building manager, construction manager, insurance underwriters, and all authorities having jurisdiction.
 - iv. Safeguarding shall also apply to all related phasing, shut-downs, swing spaces, temporary services and facilities, relocations, etc. Alternative safeguarding such as, but not limited to, fire watch personnel, or temporary fire protection systems, may be considered if acceptable to the tenant/owner and authorities having jurisdiction. Refer to, and coordinate with, fire alarm systems documents, and any associated safeguarding and impairments notes and specifications. Coordinate with fire alarm system contractor and all other trades.
 - v. Provide (and include as shop drawings submittals) a complete demolition, alteration, construction, phasing and impairment plan to include the safeguarding information above, a schedule of project milestones and related work, and an anticipated schedule for installation, impairments, programming



and all phases of final testing and completion of the work. This plan shall be coordinated with all authorities having jurisdiction, the tenant's/owner's fire prevention program manager, construction manager, and shall include any and all information, drawings, and graphics to meet the approval of the authorities having jurisdiction. The contractors shall provide firewatch personnel or temporary protection as required by any authorities having jurisdiction, the tenant/owner, or the tenant's/owners insurance underwriters.

- vi. The above impairment plan shall be approved by all authorities, tenant/owner fire prevention program manager, tenant/owner insurance underwriters, etc., prior to any shutdowns or impairments.
- vii. All costs associated with the above safeguarding during demolition, alteration, construction, phasing, shutdowns, etc. with regard to fire protection systems shall be included in the fire protection contractor's base bid.

7. Commissioning

- a. The designer shall provide fully integrated design documents to ensure all required Contractors are fully responsible for supporting the Commissioning activities for the proposed systems to be commissioned. All required labor hours and materials shall be included for, at a minimum but not limited to, meetings, supporting documentation, field testing activities, ancillary testing equipment, off-season testing, data storage, support for 10 month warranty verification (if required), etc.
- b. The designer shall cooperate with the project Commissioning Agent, and be available for consult, site visits, meetings, etc. to provide the commissioning agent with information on systems' sequences of operation and testing requirements. The designer shall incorporate all systems' sequences of operation and testing requirements into the contract specifications.

8. Piping, Fittings and Joints

- a. Piping shall meet applicable ANSI or ASTM standards requirements and shall have manufacturer's name and standard marked on each length. Joints shall meet applicable ANSI and ASTM standards requirements. Where ANSI and ASTM standard does not exist, joints and fittings shall bear UL listing symbol.
- b. Underground fire protection service piping shall be ductile-iron thickness Class 53 or Class 52, ANSI A21-51 with cement-mortar lining per ANSI A21.4. Fittings shall be ductile-iron 250 PSIG rating per ANSI A21.10 with cement-mortar lining per ANSI A21.4. Pipe Joints shall be AWWA C606 grooved end with Victaulic Style 31 couplings or push-on ANSI A21.11 with retainer glands and thrust blocks as required. All materials and installation shall conform to NFPA 24 as a minimum. Furnish and install two (2) Dresser Style 38 Couplings and retainer clamps on the incoming water service. Connect to cement lined ductile iron site water main 10'-0" outside building foundation wall.



- c. Piping for sprinkler systems and standpipe systems shall be Schedule 40 black steel conforming to ASTM A53. If seamless piping is not used, then the seam shall be installed on the top of the pipe. Seamless piping shall be used wherever possible.
 - d. Piping for use with hole-cut fittings shall have shop fabricated machine cut holes per Manufacturer requirements at predetermined positions, on the centerline of the pipe, of a size to receive the housing locating collar. Hole cutting machine shall be supplied by the fitting manufacturer. Torch cutting of the piping shall not be permitted.
 - e. Piping for use with grooved end fittings shall be roll grooved without metal removal or as per manufacture requirements. Cut grooved piping shall not be accepted
 - f. Fittings for Grooved End Steel Pipe shall be cast of ductile iron conforming to ASTM A-536 or forged steel conforming to ASTM A-234 (A-106, Gr. B), with grooved or shouldered ends for direct connection into grooved piping systems with steel pipe and shall be UL listed and FMG approved, rated for a minimum 300 psi maximum working pressure (MWP) and shall be of one manufacturer
 - g. Standard black cast iron screwed fittings shall be used on piping 2" and smaller and may be used on larger sizes.
 - h. Sprinkler piping in areas subject to magnetic fields, i.e. MRI, NMRs, etc. shall be copper Type L, ASTM B88. Supported by stainless steel hangers and rods. Provide dielectric unions at transitions to copper piping.
 - i. Dry and Pre-action sprinkler piping and fittings shall be Schedule 40 galvanized steel. Dry and pre-action system piping shall be provided with corrosion monitoring devices similar to AGF CORRINSITE, Potter PCMPK Series, or Potter PCMS-RM.
 - j. Wet sprinkler system piping shall be provided with automatic air relief vents, at high points of the system and at floor control valve assemblies. Air relief vents shall be similar to Potter Model PAV, with strainer and a ball valve in-line immediately upstream to facilitate servicing or replacing the strainer or vent without disabling the sprinkler system.
 - k. At the ends of all sprinkler system branch lines, provide 1" ball valves, and ¾" capped male hose threaded ends, to allow for periodic flushing.
 - l. The designer shall obtain approval of the owner's project manager for any alternative piping materials.
9. Pipe Hangers And Supports
- a. Acceptable products: Hanger materials shall match piping material as required for dielectric isolation. All support systems shall be UL listed and FMG approved and shall meet ASTM B633, SC1 and SC3.



- b. Support all piping included in the Work of this Section with hangers and rods attached to the building structure. Hang piping in compliance with NFPA Standards and the requirements of these standards. Attach beam clamps before application of spray fire-proofing.
 - c. Piping 2-1/2" and smaller: Carbon steel, adjustable swivel.
 - d. Piping 3" and larger: Carbon steel, adjustable clevis.
 - e. Beam Clamps: Carbon steel hanger with lock nut and retaining strap or approved equal.
 - f. Copper piping in areas subject to magnetic fields shall be supported by stainless steel hangers, rods and attachments.
 - g. Expansion Shields: Hilti HDI or approved equal.
 - h. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods. Hilti HKD or approved equal.
 - i. Space hangers and supports for all fire protection system piping according to applicable NFPA standards.
 - j. Provide steel angle supports attached to the building structure to support piping below ductwork.
 - k. Riser Clamps: Carbon steel riser clamp, black or galvanized finish.
 - l. Floor Supports: Schedule 40 black steel adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - m. All vertical drops and run-out pipes shall be supported by split ring extension type hangers.
 - n. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded. Provide hanger rods sized according to NFPA standards.
 - o. Hangers, structure and associated components shall support the weight of five times the weight of the water filled pipe plus 250 pounds at the point of attachment.
10. Valves
- a. All valves shall be installed in locations and orientations which are readily accessible for system service, maintenance, modifications, etc. Valves shall not be obstructed by, nor located above piping racks, cable trays, ducts, or other equipment. All system main shut-off / isolation valves shall be located in areas that are easily accessible without



having to enter a locked room or program space. Provide access panels for valves where located above finished hard ceilings.

b. Pressure Reducing Valves

- i. Pressure reducing valves shall be sized and located on the drawings and shall be field adjustable, pilot-operated, pressure reducing valve with pressure relief valve piped to drain riser. Spilling the pressure relief discharge piping to a floor drain within the room is not acceptable.

c. Shut-off and/or control valves shall be

- i. Outside screw and yoke valve. Ductile iron or cast iron body, bronze mounted, flanged or grooved ends, solid wedge, 2-1/2" in size and up. All bronze, solid wedge, threaded ends, 2" and under in size both to be electrically supervised, or hand wheel.
- ii. All equipment must be installed with isolation valves for service shut-off. The shut-off valves shall be screwed, grooved or flanged. If screwed ends are provided, a union or a coupling between equipment and valve shall be provided.
- iii. OS&Y Gate Valves shall be installed on all fire pump suction piping in accordance with NFPA 20.
- iv. Provide supervised ball valves on sprinkler branch lines to all electric rooms and closets provided with wet sprinkler systems.

d. Check valves shall be:

- i. Iron body, bronze mounted swing check with flanged ends, 2-1/2" in size up to 8" size; or
- ii. Iron body, spring actuated, wafer check, sizes 4" through 8"; or
- iii. Grooved end, ductile iron body, spring activated, sizes 2-1/2" through 12", suitable for vertical or horizontal installation
- iv. All check valves up to 2" in size shall be all bronze with screwed ends.

e. Backflow Preventers

- i. Double check valve assembly shall be ductile iron body, bronze mounted, flanged end with electrically supervised OS&Y, resilient wedge gate valves. Backflow prevention device and installation shall conform to requirements of local authorities and all Cross Connection Control Regulations

11. Sprinklers



- a. All sprinklers shall be listed or approved as specified per Table 2, below. All sprinklers shall be of a single manufacturer, unless noted otherwise. Sprinklers shall be as manufactured by Tyco, Reliable, Viking, or Victaulic. Models noted in Table 2 below pertain to Tyco sprinklers for general reference information only, and specified sprinklers shall be similar. Sprinklers shall match existing manufacturer in the specific buildings or areas undergoing renovation.
- b. Sprinklers shall be furnished and installed to conform to manufacturer's listing.
- c. All sprinklers shall be coordinated with a final reflected ceiling plan to arrive at a suitable pattern consistent with proper sprinkler protection.
- d. All sprinklers within 8'-0" of the floor in areas without finished ceilings, and environmental rooms, shall have sprinkler guards, wire gauge type that is listed to be used with the specified sprinkler.
- e. Sprinklers shall be located in center of tiles.
- f. Spare Sprinklers: Provide 20-gauge steel sprinkler cabinet with red enamel finish. Furnish the quantities of spare sprinklers for each type installed as required by NFPA 13. Furnish sprinkler wrench for each type of sprinkler installed. Mount cabinet in mechanical room or fire pump room, in an accessible location.
- g. Sprinklers shall be similar to those specified in Table 2, below:



Table 2

LOCATION OR HAZARD TYPE	MFR. (Note 1)	MODEL (Note 1)	RESPONSE TYPE	SPRINKLER TYPE	K-FACTOR	FINISH TYPE	TEMPERATURE RATING (°F)	NOTES
Light Hazard areas with Ceilings	Tyco	Series RFI	Quick	Concealed Pendent	5.6	Pure White Cover Plate	139°F cover & 155°F	None
Light Hazard areas with ceilings	Tyco	Series TY-FRB	Quick	Recessed Pendent or Pendent	5.6	Chrome Plated	155°F	None
Light Hazard areas without ceilings	Tyco	Series TY-FRB	Quick	Upright	5.6	Natural Brass	155°F	None
Light Hazard areas with ceilings	Tyco	Series TY-FRL	Quick	Horizontal Sidewall	5.6	Chrome Plated	165°F	None
Labs, Storage Rooms and other Ordinary Hazard areas with ceilings	Tyco	Series TY-FRB	Quick	Recessed Pendent or Pendent	5.6	Chrome Plated	155°F	None
Ordinary Hazard areas without ceilings	Tyco	Series TY-FRB	Quick	Upright	5.6	Natural Brass	155°F	None
Cold rooms, loading docks and other cold areas with ceilings	Tyco	Series DS-1 & DSB-2	Quick	Dry Pendent with Dry Sprinkler Boot	5.6	Chrome Plated	155°F	Provide dry sprinkler boot at each sprinkler
Animal Holding Rooms or Vivarium areas with ceilings	Tyco	RAVEN Institutional	Quick	Institutional Pendent	5.6	Chrome Plated	165°F	Provide caulking around escutcheon
Glazing Requiring 2-hour protection	Tyco	Model WS	Quick	Pendent Vertical Sidewall or Horizontal Sidewall	5.6	Chrome Plated	155°F	Horizontal window mullions shall not be installed. Install per mfr's specifications.
Glasswash, cage and rack washers, autoclaves, and above kitchen cooking equipment	Tyco	Series TY-FRL	Quick	Pendent Or Upright	5.6	Chrome Plated	286°F	UL Glass bulb sprinklers shall not be used in food prep areas



LOCATION OR HAZARD TYPE	MFR. (Note 1)	MODEL (Note 1)	RESPONSE TYPE	SPRINKLER TYPE	K-FACTOR	FINISH TYPE	TEMPERATURE RATING (°F)	NOTES
MRI, CT, X-ray and other areas with magnetic fields	Reliable	Model F4FR- NF	Quick	Concealed Non- Ferrous Pendent	5.6	Pure White Cover Plate	135°F Cover Plate & 155°F Pendent	UL listed only

Notes:

1. Refer to Paragraph 'a' above.



12. Alarm valves

a. Wet Pipe Alarm Valve

- i. Wet alarm valve shall be UL listed and FMG approved for a wet pipe sprinkler system, complete with ductile iron body, flanged or grooved outlet, main drain valve, pressure gauges, alarm port, external bypass, hand hole with cover, hinged clapper assembly and other required trimmings. Valve shall be equal to Reliable Model E3, Viking Model, J-1, Victaulic Series 751 or Tyco Model AV-1-300.
- ii. Valve trim shall include pressure activated electric alarm switches, flow switch, and electric alarm bell mounted to exterior of building.

b. Dry Pipe Alarm Valve

- i. Dry pipe alarm valve shall be UL listed and FMG approved for a dry pipe sprinkler system, complete with ductile iron body, flanged or grooved outlet, drain valve, primary water valve, ball drip valve, alarm test valve, priming chamber, fill line attachment, pressure gauges and air control valve assembly, similar to Tyco Model DPV-1.
- ii. Provide AGF CORRinSITE Model 7700, Schedule 40 galvanized, In-Line Spool and Mechanical Tee fittings throughout dry sprinkler distribution piping system. In-Line Spool and Mechanical Tee fittings shall be installed in accordance with AGF recommendations shall be installed so that each viewing window can easily be viewed and is not obstructed by other MEP/FP components or equipment, and shall be in an accessible location.
- iii. Furnish and install listed air compressor to maintain air pressure in the dry pipe system, automatically. Compressor shall be sized as required for system in accordance with NFPA 13. For a tank-mounted air compressor, provide Flex Hose made of stainless steel to reduce vibration and noise transmitted through the piping system from the air compressor.
- iv. To accelerate operation of the dry valve, furnish and install Tyco VIZOR Electronic Dry Pipe Accelerator (EDPA) with 120V power supply. Accelerator shall be monitored for high/ low pressure and trouble by the building's fire alarm system.

c. Pre-Action Sprinkler System

- i. Provide complete addressable UL-listed/FMG-approved, positive-supervised, single-interlocked cross-zoned, electrically actuated pre-action sprinkler system.



- ii. Deluge Valve: Hydraulically operated differential diaphragm type, fully trimmed including electric actuator, air and water pressure gauges, low pressure warning switch, 2 inch main drain, pressure and fire alarm switch, and external reset. Similar to Tyco Model DV-5
- iii. Control / Alarm / Release Panel: Addressable intelligent control panel with alarm, and solenoid circuitry, complete with 120 volt power supply, circuit breakers, battery charger, and batteries. Control panel shall be compatible with deluge valve, smoke and/or heat detectors and all system components. Similar to AUTOPULSE IQ-318.
- iv. Fire Detection System: Provide complete smoke sensing fire detection system at ceiling above with smoke detectors installed and spaced in compliance with manufacturer's specifications and NFPA 72. Similar to Notifier FSP-851 FlashScan photoelectric smoke detector. Only if ambient conditions cause the use of smoke detectors to be unfeasible, such as generator rooms, provide complete heat sensing fire detection system at ceiling above with heat detectors installed and spaced in compliance with manufacturer's specifications and NFPA 72. Similar to Notifier FSP-851R FlashScan thermal/rate-of-rise heat detector. Refer to Section 28.
- v. Sequence of Operation:
 - 1. The piping system shall be supervised with low air pressure to detect damage to the piping system, or opened or damaged sprinklers. However a break, leak or opening of a sprinkler shall not open the deluge valve, nor cause water to discharge from the system in the absence of at least two detectors activations. A trouble alarm shall sound to indicate a piping leak without discharging water or flooding the system.
 - 2. Operation of the first detector will operate local audible/visual devices and signal the Fire Alarm System. Deluge valve shall remain closed at this point.
 - 3. Operation of any second detector in the protected space shall also signal the Fire Alarm System. Deluge valve shall open at this point.
 - 4. Water will only flow from the sprinklers which activate due to heat at the individual sprinklers.
- vi Detectors for MRI's, imaging spaces, and other areas with magnetic fields, electro-magnetic interference or radio frequency interference shall be compatible with the environment and shall be configured to address the specific



area equipment and environments. System and/or detectors shall not be subject to false alarms or trouble conditions due to magnetic reed switches or other componentry interacting with the magnetic fields or other environmental conditions. Detectors shall be provided with (1) appropriate components or shielding, coordinated with the equipment manufacturer, or (2) shall have the capability of disabling the magnetic reed switch, or (3) shall not be provided with a magnetic reed switch. All materials shall be compatible with the pre-action system control/alarm/release panel.

- vii. Provide AGF CORriNSITE Model 7700, Schedule 40 galvanized, In-Line Spool and Mechanical Tee fittings throughout pre-action distribution piping system. In-Line Spool and Mechanical Tee fittings shall be installed in accordance with AGF recommendations shall be installed so that each viewing window can easily be viewed and is not obstructed by other MEP/FP components or equipment, and shall be in an accessible location.

13. Fire Department Hose Valves and Cabinets

- a. Provide 2-1/2" fire department hose valves, similar to Croker 5035.
- b. Wherever system pressures may exceed 175 PSIG, Fire Department valves shall be field adjustable pressure reducing type so that no valve is set for greater than 175 psig at outlet, similar to Croker 5410. The Contractor shall be responsible for locations of pressure reducing valves based upon a certified fire pump curve and hydraulic calculations.
- c. Provide fire department hose valves cabinets where noted on the contract drawings. Cabinets shall be complete with 2-1/2" angle type valves and shall be fully recessed type similar to Croker 1710 or 1720, depending on type of hose valve selected.

14. Fire Department Inlet Connections

- a. Surface or Flush Mounted: Polished chrome with escutcheon and two-way, three-way, or four-way connection, according to the fire protection system flow demands of the particular building. Each inlet shall have a clapper valve, and plastic cap with chain. Branding shall be: "Combination Standpipe and Sprinkler Systems" or "Standpipe" or "Auto Sprinkler" according to the systems(s) served. Connection shall be similar to Croker 6310, 6315 or 6320, depending on quantity of inlets needed.
- b. Freestanding: Polished chrome with escutcheon and two-way, three-way, or four-way connection according to the fire protection system flow demands of the particular building. Each inlet shall have a clapper valve, and plastic cap with chain. Branding shall be: "Combination Standpipe and Sprinkler Systems" or "Standpipe" or "Auto Sprinkler" according to the systems(s) served. Connection shall be similar to Croker 6512, 6527 or 6530, depending on quantity of inlets needed.



15. Alarm devices

a. Water Flow Switches

- i. Vane type switch for mounting horizontal or vertical, with two contacts rated 10 Amp at 120 volt AC, with adjustable 60 second time delay mechanism.
- ii. Pressure type switch with two sets of double throw, single pole contacts with adequate pressure differential to prevent false operation, and 60 second time delay mechanism. Provide bleeder valve and pressure gauge, as necessary, to allow all pressure switches to be properly tested.

b. Supervisory Tamper Switches

- i. OS&Y Gate Valves: Tamper switch with two contacts rated 10 Amp at 120 volts AC.



22 0510 – Existing Building Plumbing Systems Description

1. Armenise Building
 - a. 4" Domestic Water service
 - i. Booster pump
 - b. Hot Water Generation
 - i. Steam-fired heater
 - c. 4" Non-Domestic System
 - i. Steam-fired non-domestic heater
 - d. 8" Sanitary Sewer
 - e. 6" Storm Sewer
 - f. 4" Natural Gas Service
 - i. Gas Booster Pump
 - g. RO System
 - h. Lab Air System
 - i. Lab Waste System which is piped to Goldenson
 - j. Vacuum System
 - k. CO₂ Tank Farm
2. Building C
 - a. 3" Domestic Service
 - b. Three (3) heaters in basement
 - c. Non-Potable Water System
 - d. 4" Sanitary (ejected) 3" PD – 5" Sanitary
 - e. 5" Storm
 - f. 4" Natural Gas System (meter located in Basement)



- g. 4" Laboratory Waste System
 - i. Pumping Station to TEMC
 - h. Compressed Air System
 - i. Vacuum System
 - j. 1-1/2" ROS and ROR System (located in Basement)
 - k. RO Systems for frog area on 7th Floor
 - l. 2" Tempered Water System
3. Countway Library
- a. 6" Domestic Water Service
 - b. Hot water heater located in Basement
 - c. 8" Storm Sewer
 - d. 6" Sanitary Sewer
 - i. Sewer Ejector
4. Goldenson Building
- a. Two (2) 6" Domestic Water Services in Basement
 - i. Duplex 3" CW Backflow Preventors – 2 sets
 - ii. Potable Heater located in Basement
 - b. Non-Domestic Water (two 6" Backflow Preventors) – 2 sets
 - c. 5" Sanitary Sewer (6" Sanitary Sewer)
 - d. RO Water System (located in Penthouse)
 - e. CA System
 - f. CO₂ System
 - g. Laboratory Waste System, Pump Station (located in Basement)
 - h. High Pressure Air Main / Riser



5. Gordon Hall
 - a. 2" CW, 1" HW, 1-1/2" HWR risers, ground floor, fed from tunnel below.
 - b. Lab Waste Neutralization Tank in Basement (30 gallon) above ceiling, 3" AW-UP
 - c. Lab Waste Neutralization Tank in second floor above ceiling in kitchen (30 gallon)

6. Harvard Institutes of Medicine (HIM)
 - a. Incoming Water Service or Source
 - i. Triplex booster pumps
 - b. Hot Water Generation
 - i. Duplex domestic water heaters located in basement
 - c. Duplex non-domestic water heaters located in basement
 - d. 15" storm drain
 - e. 10" storm drain
 - f. 12" sanitary sewer
 - g. RO System located in basement
 - h. Duplex vacuum pumps – Mezzanine Level
 - i. Triplex air compressors – Mezzanine Level
 - j. 4" gas service
 - k. Lab Waste System located in basement
 - i. Two (2) 800 gallon pH adjustment tanks
 - l. CO₂
 - m. Helium
 - n. Nitrogen
 - o. Nitrous Oxide
 - p. Oxygen



- q. Special Gas
- r. WAGD (Waste Anesthesia Gas Disposal)
- 7. Laboratory for Human Reproduction and Reproductive Biology (LHRRB)
 - a. 4" CW service
 - i. Booster pump in basement
 - ii. Hot water heater in basement
 - b. 6" storm sewer
 - c. 6" sanitary sewer
 - i. pH System in basement
 - d. Lab Waste System
 - i. pH System in basement
 - e. Natural Gas System
 - f. RODI System
 - g. CO₂ System
- 8. New Research Building (NRB)
 - a. 6" CW services (low, high zone)
 - i. Domestic water heater in chiller vault
 - ii. Non-domestic water heater in chiller vault
 - b. Three (3) 12" storm sewer
 - c. Two (2) 8" sanitary sewer
 - d. One (1) 6" sanitary sewer
 - e. RODI System
 - f. LA System
 - g. LV System



- h. Lab Waste System (pH Tank System)
- 9. Seeley G. Mudd
 - a. 4" CW service
 - i. Booster pump in basement
 - b. 4" G services
 - c. 10" sanitary sewer
 - d. 8" storm
 - e. 10" storm to manhole
 - f. LV System
 - g. LA System
 - h. Lab waste system
 - i. Nitrogen system
- 10. Tosteson Medical Education Center (TMEC)
 - a. 4" domestic service (HW, HWR) in basement
 - b. Lab waste system (tank in basement)
 - c. Natural Gas
 - d. 8" sanitary sewer
 - e. 12" storm sewer
 - f. LA System (compressed air in basement)
- 11. Vanderbilt Hall
 - a. 4" domestic water service and 3" cold water from tunnel
 - i. Triplex domestic booster pump
 - ii. Backflow preventer
 - b. Duplex steam-fired water heaters 120°F



- i. 3" hot water
 - ii. 1-1/2" hot water circulation
 - iii. 2" 140°F HW
 - iv. 140°F HW circulation
 - v. Duplex 120°F circulation pumps
 - vi. Duplex 140°F circulation pumps
 - vii. Master mixing valve
- c. 3" Gas from tunnel
 - d. 6" sanitary sewer to exterior grease trap
 - e. 6" sanitary sewer
 - f. Multiple 4" building sanitary sewers
 - g. 5" sanitary sewer
 - h. 10" storm sewer
 - i. 6" storm sewer
 - i. Two (2) sets of sump pumps

12. Warren Alpert Building

- a. 6" Domestic Water Service
 - i. Duplex 4" reduced pressure backflow preventers – containment
 - ii. Duplex steam-fired domestic water heaters
- b. Duplex 4" Non-Domestic Reduced Pressure Backflow Preventers
 - i. Duplex steam-fired non-domestic water heaters
 - ii. Non-domestic circulation pumps
- c. 4" Natural Gas Service
- d. Tempered Water System



- i. Tempered water storage tank
 - e. 12" Sanitary Sewer
 - f. pH Neutralization System
 - i. Duplex lab waste pumping stations
 - g. 15" storm sewer, 6" storm sewer, 12" storm sewer
 - i. Duplex sump pumps
 - ii. Foundation drainage system with setting basin and pumps.
 - h. Triplex Compressed / Lab Air System
 - i. Duplex Lab Vacuum System
 - j. WAGD (Waste Anesthesia Gas Disposal) System
 - k. CO₂ System – Manifold
 - l. RO/DI Water System
 - m. Bottle Filling Station for Animal Watering
- 13. 158 Longwood Avenue – Lack of Drawings
 - a. Cold water
 - b. Hot water
 - c. Sanitary
 - d. Storm
- 14. 160-164 Longwood Avenue
 - a. 1-1/2" domestic water service, 1" domestic water service
 - b. Two(2) duplex sets of gas-fired water heaters
 - c. Two (2) 1" Natural Gas services
 - d. 6" sanitary sewer below lab
- 15. 180 Longwood Avenue



- a. 4" Domestic Water Service
 - i. duplex domestic water booster pump
 - ii. 3" containment reduced backflow preventor
 - b. Instantaneous steam-fired domestic water heater
 - c. 3" Non-Domestic Water System
 - i. 3" in-plant reduced backflow preventor
 - d. Natural Gas system
 - e. Tempered water system
 - f. Sanitary Sewer
 - g. Storm Sewer
 - h. Lab Waste Sewer
 - i. CO₂ manifold system
 - j. Nitrogen manifold system
 - k. Lab vacuum system
16. 641 Huntington Avenue
- a. 2" Domestic water service
 - i. Hot, cold and hot water circulation
 - b. Electric water heater
 - c. 2" Natural Gas service
 - d. 6" sanitary sewer
 - e. Storm sewer – below slab
 - f. Clear water waste system
17. School of Dental Medicine
- a. 4" cold water service



- i. Simplex steam-fired water heater
 - b. Non-domestic water system
 - i. Simplex steam-fired non-domestic heater
 - c. 6" sanitary sewer – below slab
 - d. Storm sewer
 - e. 2" Natural Gas
 - f. pH adjustment system
 - g. Dental air system
 - h. Dental vacuum system
 - i. Surgical vacuum and WAGD system
 - j. WAGD (Waste Anesthesia Gas Disposal) system
- 18. Research and Education Building (REB)
 - a. 6" cold water service
 - i. Triplex domestic water booster pump
 - ii. Duplex 6" backflow preventors
 - b. Steam-fired domestic heaters, simplex, two (2) locations – basement and penthouse
 - i. High and low zone
 - c. 4" non-domestic system
4" duplex reduced pressure backflow preventors
Duplex steam-fired water heaters – penthouse
 - d. Tempered water system
 - e. 12" sanitary sewer and 6" sanitary sewer
 - i. Triplex sewage ejectors
 - f. 15" storm sewer and 10" storm sewer
 - i. Duplex sump pumps



- g. 2" Natural Gas service
- h. RO/DI system
- i. RO Reject System
 - i. High pressure air main
- j. Duplex lab air system
- k. Duplex lab vacuum system
- l. pH adjustment system
 - i. 4" lab waste sewer

22 0520 – Plumbing Design Criteria

1. Design Statement

- a. The new Plumbing systems shall have the following characteristics:
 - i. Protection of the public water supply.
 - ii. User safety and comfort.
 - iii. Universal accessibility.
 - iv. Energy responsiveness.
 - v. Flexibility for future changes.
 - vi. Durability.
 - vii. Ease of maintenance.
 - viii. Reliability and redundancy.
- b. Every effort will be made to design, layout and install equipment in locations which will tend to encourage routine preventive maintenance by providing easy access for maintenance personnel. Manual isolation valves will be provided to enable servicing, expansion of, renovation or construction of any part of the existing facility without unscheduled interruption of services in adjacent areas.



2. All systems, equipment and fixtures shall be designed in accordance with the Massachusetts State Building Code, Massachusetts State Plumbing Code, applicable local Codes and Ordinances, the Owner’s Design Guidelines, and good engineering practices.
3. The Plumbing Subcontractor shall purchase (furnish and install) domestically-produced products for all systems when possible.
4. Codes, Standards and References
5. Commissioning
 - a. The Design Team shall provide fully integrated design documents to ensure all required Contractors are fully responsible for supporting the Commissioning activities for the proposed systems to be commissioned. All required labor hours and materials shall be included for, at a minimum but not limited to, meetings, supporting documentation, field testing activities, ancillary testing equipment, off-season testing, data storage, support for 10 month warranty verification (if required), etc.
 - b. The Design Team shall work with the project Commissioning Agent to incorporate all of their testing requirements into the contract specifications.
6. Sustainable Design Initiatives
 - a. The project has been registered under the USGBC LEED – NC Version 2.2 Green Building Rating System. Contractor responsibilities relative to the LEED Certification process in general and credit documentation in particular are defined in Division 1.
 - b. Plumbing systems and equipment with particular emphasis on sustainable design and integral to LEED Certification include, but are not limited to, the following:
 - i. Premium Efficient Motors
 - ii. Low Flow Plumbing Fixtures
 - iii. Low VOC Sealants and Adhesives
 - iv. Construction IAQ Management Plan
7. Coordination of Work
 - a. The Plumbing Contractor shall compare his drawings and specifications with those of other Trades and report any discrepancies between them to the Architect and obtain from the Architect written instructions for changes necessary in the mechanical or electrical work, to ensure that all work is installed in coordination and cooperation with other Trades installing interrelated work. Before installation, the Plumbing Contractor shall make proper provisions to avoid interferences in a manner approved by the



Architect. All changes required in the work of the Plumbing Contractor caused by his negligence, shall be corrected by him at his own expense, to the Architect's satisfaction.

- b. Locations of piping and equipment shall be adjusted to accommodate the new work with interferences anticipated and encountered during installation. The Plumbing Contractor shall determine the exact routing and location of his systems prior to fabrication or installation of any system component. Accurate measurements and coordination drawings will have to be completed to verify dimensions and characteristics of the various systems' installations.
- c. Lines which pitch shall have the right-of-way over those which do not pitch. For example, waste piping shall normally have the right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.
- d. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. The Plumbing Contractor shall provide manual air vents and drains as required for his work to affect these offsets, transitions and changes in direction, as applicable.
- e. All work shall be installed in a way to permit access (without damage to other parts) of valves, cleanouts, shock absorbers, traps and all other system components provided under this Contract requiring periodic replacement or maintenance. All piping shall be arranged in a manner to clear the openings of swinging overhead access doors, ceiling tiles and cleaning access doors in ductwork.
 - i. Access to any and all components requiring servicing, adjustment, calibration, maintenance or periodic replacement shall be provided so that the Owner's operations personnel can freely gain access without removal of any materials other than the access panel or ceiling tile. Access shall be understood to mean free, clear and unobstructed from the floor up to the device and/or component being serviced.
 - ii. Fire-rated access doors with closers shall be provided for all rated assemblies.
- f. The Contract Drawings are diagrammatic only intending to show general runs and locations of piping, valves, equipment and specialties and not necessarily showing all required offsets, details and accessories and equipment to be connected. All work shall be accurately laid out with other Trades to avoid conflicts and to obtain a neat and workmanlike installation which will afford maximum accessibility for operation, maintenance and headroom.
- g. Where discrepancies in scope of work as to what Trade provides items, such as starters, disconnects, flow switches, electric control components, etc., exist, such conflicts shall be reported to the Architect prior to signing of the Contract. If such action is not taken,



the Plumbing Contractor, as applicable, shall furnish such items as part of his work, for complete and operable systems and equipment, as determined by the Architect.

- h. Where drawing details, plans and/or specification requirements are in conflict and where pipe is shown to be different between plans and/or between plans and sections or details, the most stringent requirement will be included in the Contract. Plumbing systems and equipment called for in the specification and/or shown on the drawings shall be provided under this Contract as if it were required by both the drawings and specifications. However, prior to ordering or installation of any portion of work which appears to be in conflict, such work shall be brought to Architect's attention for direction as to what is to be provided.
 - i. Final location of all outlets, sinks, faucets and trim shall be coordinated with the Architect's elevation plans and/or other Architectural details, as applicable. Offsets of piping, added fittings, valves, elbows, flexible connections, etc., shall be provided as required to comply with the Architectural floor plans, elevation plans and/or installation details. Obtain approval of locations of all devices from Architect in the field, prior to installation.
 - j. Equipment and/or hoods, dishwashers, etc., or other type of equipment shown on the Plumbing or Architectural drawings to be provided with services, such as piping, traps, drains, valves, etc., shall be included under this Contract as applicable, including all piping connections to systems, to make equipment completely operable. Additional piping, valves, flexible fittings, etc., shall be provided to accomplish the above requirement, as required, all as part of this Contract, at no additional cost to the Owner.
8. Coordination Drawings
- a. Before materials are purchased, fabricated or work is begun, the Plumbing Contractor shall prepare coordination drawings in cooperation with all trades for all floors/areas, including buried systems/services (all-Trade-composite at 1/4" scale), showing the size and location of his equipment and lines, in the manner described herein under General Requirements. Any sections of difficult areas shown in the contract documents are for reference only and do not dictate how to layer or install the trades.
 - b. The HVAC Contractor shall take the lead in the coordination drawing process to produce the Architectural backgrounds. A detailed drawing schedule shall be produced to conform to the scale drawing requirements as herein listed and submitted for review. Coordination drawings are for the CM and Architects/Engineer use during construction and shall not be construed as shop drawings or as replacing any shop drawings. The coordination drawings, when corrected for actual "as-built" conditions, will be reviewed by the Architect, corrected and become the Record Drawings to be submitted to the Owner for his use.
 - c. The cost of producing and reproducing the drawings will be included under the Contract of each Trade, including the cost or preparation of the Architectural building outlines.



This process may include multiple revisions to these drawings which will be included in the cost. The intent is to provide a fully coordinated set of documents between trades no matter how many times they may have to be redone. The HVAC Contractor shall take the lead to produce the Architectural backgrounds, show all ductwork, piping, etc., and circulate the drawings to any of his Subcontractors and the other Trades (Plumbing, Fire Protection, Electrical, etc.), so that they can indicate all their work as directed by the CM and Architect as required, to result in a fully coordinated installation.

- d. In addition to the regular coordination drawing review, the plumbing work will also be reviewed by the Architect/Engineer to ensure that the system and equipment arrangements are suitable to provide maintenance access and service as follows:
 - i. Valves and instrumentation should be grouped where possible and positioned in accessible locations.
 - ii. Valves on all insulated piping shall be furnished and installed with extended stem handles.
- e. Prepare a complete set of computer-based drawings
 - i. Prepare a complete set of computer based drawings:
 - ii. Format shall be:
 - 1. AutoCAD (Latest Version)
 - 2. REVIT (Latest Version)
 - iii. Scale not less than 1/4" scale equals 1'-0", showing basic layout for the structure and other information as needed for preparation of Coordination Drawings.
 - iv. The drawings shall indicate the layout of all specialty tradework as indicated herein and shall be designated as Coordination Drawings.
 - v. Any drawing requirement to assist the Contractor will require:
 - 1. A signed liability release form will be required from the Contractor prior to the release of the disk from the Engineer.
 - vi. For 3-D projects see Section 220510 "3D Building Information" for additional information
- f. Highlight all fire rated partitions on the Coordination Drawings for appropriate coordination.
- g. The main paths for the installation or removal of all MEP & FP equipment from mechanical and electrical rooms shall be clearly indicated on the Coordination Drawings.



- h. Each of the specialty trades shall add its work to the base drawings with appropriate elevations and grid dimensions. Specialty trade information shall be required for mechanical rooms, crossovers and for spaces above ceilings where congestion of work may occur such as corridors and, where required, entire floors.

Drawings shall indicate horizontal and vertical dimensions to avoid interference with structural framing, ceilings, partitions and other services. Indicate elevations relative to finish floor for bottom of piping. Sections shown in the contract drawings are diagrammatic only and all trades shall share and coordinate sectional views used.

- i. Specialty Trade shall include:
 - 1. Plumbing system
 - 2. HVAC piping and associated control systems
 - 3. Electrical
 - 4. Sheet metal work
 - 5. Fire protection system
 - 6. Automatic temperature control
 - 7. Fire alarm
 - 8. Security
 - 9. Telecommunications
 - 10. Pneumatic tube
 - 11. Commissioning Review and Comments
- i. Upon completing their portion of the Coordination Drawings, each specialty trade shall sign, date and submit the Coordination Drawings to the CM, Architect/Engineer for review.
- j. Where conflicts occur with placement of materials of various trades, the CM shall be responsible to coordinate the available space to accommodate all trades. Any resulting adjustments shall be initialed and dated by the affected specialty trade Contractor. The CM shall then final date and sign each drawing.
- k. Fabrication of materials shall not start until Coordination Drawings have been signed, reviewed, and distributed to all parties as indicated herein.
- l. Distribution of Coordination Drawings: (Modified for clarification)



- i. The CM shall provide one print of each Coordination Drawing to:
 - 1. Each specialty trade Subcontractor.
 - 2. Owner.
 - 3. General Contractor.
 - 4. Architect (for record purposes).
 - 5. Engineer.

- m. After Distribution
 - i. Resolve all interferences not previously identified.

- n. Coordination Drawings shall include but are not necessarily limited to:
 - i. Structure. (Beams, cross bracing, columns, gusset plates, etc.).
 - ii. Partition/room layout, including indication of smoke and fire resistance rated partitions.
 - iii. Ceiling layout and heights.
 - iv. Light fixtures.
 - v. Access panels.
 - vi. Sheet metal, heating coils, heat pumps, grilles, diffusers, duct flanges, and pipe hanger/supports and pipe support steel, guides, expansion compensators, kitchen exhaust access doors, and take-offs from the duct risers, etc.
 - vii. All heating piping and valves.
 - viii. Smoke and fire dampers including access doors.
 - ix. Soil, waste and vent piping.
 - x. Primary water and gas pipes.
 - xi. Major electrical, fire alarm, and security conduit runs (All sizes) panelboards, feeder conduit and racks of branch conduit (All). Motor control centers, starters and disconnects including shaft coordination for larger conduit riser junction boxes to ensure access for JB's and JB's sized to access all cables, and access to splice cables.



- xii. Sprinkler piping and heads.
- xiii. All equipment, including items in the Contract as well as Owner Furnished / Contractor Installed (O.F.C.I.) and Owner Furnished / Owner Installed (O.F.O.I.) items.
- xiv. Equipment located above finished ceiling requiring access for maintenance and service. In locations where acoustical lay-in ceilings occur indicate areas in which the required access area may be greater than the suspended grid systems.
- xv. Rainwater piping
- xvi. Existing conditions, including but not limited to, Mechanical, Plumbing, Fire Protection and Electrical items.
- xvii. ATC panels
- xviii. Cable tray
- xix. Beam Penetrations
- o. All shaft coordination drawings shall be detailed with the appropriate sizes for all ducts, HVAC pipe, conduits, fire protection piping & Plumbing waste, vent, water, gases etc. Hanger support types, miscellaneous support steel shall be detailed to allow for proper clearances and appropriate insulation thickness. Shaft coordination drawings shall be submitted for review in plan and elevation views.
- p. The Architect's response to all requests for information (RFI's) generated by the trade contractors shall be distributed to all other affected trades as if this information was contained in the original contract documents. In other words, the party that issues an RFI is responsible for distributing the information to all affected parties.
- q. The Plumbing Contractor must include in his bid sufficient dollar amounts to coordinate the work of this Contract. This project is complex and will require additional time to coordinate all Trades and allow implementation of the Owners Standards and maintenance serviceability requirements. This requirement shall include, but not be limited to, producing the coordination drawings, as many times and as many drawings as required, to ensure serviceability of equipment, as approved by the Architect.

9. Record Drawings

- a. The Plumbing Contractor shall maintain, current at the site, a set of Contract Drawings for his portion of the work on which he shall accurately show the actual installation of all work provided under his Contract indicating any variation from the Contract Drawings, in accordance with the General Conditions and Supplementary General Conditions.



Changes whether resulting from formal change orders, requests for information, or other instructions issued by the Architect shall be recorded. Include changes in sizes, location and dimensions of piping, equipment, etc.

- b. The Plumbing Contractor shall indicate progress by coloring-in various pipes and associated appurtenances exactly as they are installed. This process shall incorporate both the changes noted above and all other deviations from the original drawings whether resulting from job conditions encountered or from any other causes.
- c. The marked-up and colored-up prints will be used as a guide for determining the progress of the work installed. They shall be reviewed periodically by the Architect and Owner's representatives and they shall be corrected if found either inaccurate or incomplete. This procedure is mandatory. Marked up drawings shall include all flow diagrams, schedules, details and control diagrams.
- d. The Plumbing Contractor shall meet at a minimum on a monthly basis, with the Owner's representative to transfer the information from his Plumbing marked-up and colored-up prints to a set which will become the basis for preparation of as-built drawings.
- e. Upon completion of the project, each Contractor shall submit his marked-up drawings to the Architect for review and comment. After the Architect reviews and comments on this set of documents, each Contractor shall prepare as-built drawings on CAD using AutoCAD (Latest Version). When the work is completed, each Contractor shall provide 2 hard copies to the Architect for submittal to the Owner and disks with all documentation and a set of reproducible drawing plots marked "As-Built" drawings. The Contractor shall bear all costs of producing the CAD "As-Built" drawings, providing all necessary drawing changes and printing the reproducible drawings for the work under his charge.

10. RO / DI Water System

- a. The RODI system manufacturer shall provide a trained Factory Field Service Engineer or Technician for installation supervision, media loading, system start up, loop balancing and sanitization.
- b. System start up shall include verification that all equipment and controls are in working order and that the system equipment provides the water quality as specified herein.
- c. Training for the RODI system shall consist of a minimum of 8 hours of time for a factory-trained representative to train the Owner's operators on the theory of the equipment supplied as well as the operation of each piece of equipment.

11. RO / DI Water Decontamination



- a. This Contractor shall be responsible for final decontamination of the complete RO/DI system including existing loop piping. Decontamination method shall be in accordance with Owner's requirements.
- b. The chemical disinfectant "Minnicare" or equal shall be used. The dilution dosage shall be 0.5% minimum to 3.0% maximum. The dilution must be calculated and recorded on log sheets. The contact time shall be 24 hours.
- c. Contractor shall perform microbiological testing prior to decontamination.
- d. The mixed bed deionizers shall be bypassed or disconnected.
- e. The ultra-violet sterilizers shall be turned off.
- f. Contractor shall change filters and clean housing.
- g. Add the appropriate amount of disinfectant to the storage tank to circulate the disinfectant through the loop. All use points shall be opened briefly to expose decontamination solution. Minnicare shall be verified at each point of use by using a test strip.
- h. Shut down the distribution pump and isolate the loop to maintain solution contact time.
- i. After 24 hours, the tank shall be drained and rinsed. The loop return shall be diverted to drain and the rinse water shall be checked for positive oxidant response.
- j. Tank shall be filled with RO water and the mixed beds connections shall be flushed with clean RO water.
- k. The mixed beds shall be recommended to the system only after no decontamination solution is detected.
- l. The pumps and the UV sterilizers shall be turned on and the loop shall be slowly pressurized.
- m. All use points shall be flushed clean.
- n. The loop return diverted to drain shall be run until it is free of decontamination solution and then reconnected to the tank. After the system is running for one hour, all use points shall be flushed.

12. Testing of Purified Water Systems

- a. General
 - i. All piping systems shall be subjected to testing with water, nitrogen, gas or air as noted and shall hold tight at the pressure head stated for the time interval



required without adding air or water. While any system is being tested, required head or pressure shall be maintained until all joints are inspected. All systems tested in the existing building shall be tested with air before water.

- ii. All tests shall be witnessed by the GC/CM having jurisdiction and the Architect/Engineer, with 48 hour notice given these authorities.
 - iii. All equipment, material and labor required for testing any of the various systems or any part thereof shall be furnished by this Contractor.
- b. High Purity Water Piping Systems: Upon completion of these piping systems, including cooling for a minimum of (1) hour and the system empty of water, a test using compressed nitrogen gas N.F. or clean dry air can be done with the pressures not to exceed 5 psi to determine any obvious leaks. A hydrostatic test shall be done by filling the system with product water and opening valves and vents to purge the system of any air. Begin pressurizing the system in 10 psi increments up to 100 psi and holding the pressure for a minimum of 2 hours and up to a recommended 12 hours. Due to the natural creep effects of plastic pipe, the pressure should be checked after 1 hour. If the drop is less than 10 psi, pump the pressure back up. At this time, the system may be pressurized to the system pressure. If the pressure decreases more than 10% and ambient temperatures have been maintained, consider the test a failure. If the pressure drops less than 10 psi after 1 hour, pump the pressure back up to system pressure. After 2 or 3 hours the pressure holds, the test will be considered a success. Refer to manufacturer's recommendations and procedures for additional information.
- c. Defective Work: If inspection or tests show defects, such defective work or material shall be replaced and inspection and tests shall be repeated. All repairs to piping shall be made with new materials. No caulking of screwed joints or holes will be acceptable.

22 0553 – Plumbing Identification

- 1. General
 - a. Acceptable manufactures contingent on compliance with the specification and Harvard Medical School Piping System Control.
 - i. Seton
 - ii. W. H. Brady Company
 - iii. Marning Services Incorporated
- 2. Pipe Identification and Valve Tags



- a. All piping, except that piping which is within inaccessible chases, shall be identified with semi-rigid plastic identification markers equal to Seton Setmark pipe markers.
 - i. Direction of flow arrows is to be included on each marker.
 - ii. Each marker background shall be appropriately color coded with a clearly printed legend to identify the contents of the pipe in conformance with the "Scheme for the Identification of Piping Systems" (ASME A13.1-1981).
 - iii. Setmark snap-around markers shall be used for overall diameters up to 6" and strap-around markers shall be used above 6" overall diameters.
 - iv. Markers shall be located:
 1. Adjacent to each valve
 2. At each branch
 3. At each cap for future
 4. At each riser takeoff,
 5. At each pipe passage through wall (each side)
 6. At each pipe passage at 20' – 0" intervals maximum.
 - v. Underground pipe markers:
 1. Provide detectable tape on all underground piping:
 2. Labels shall be color coded and labeled the same as indoors.
 - vi. Valve Tags
 1. All valves shall be designated by distinguishing numbers and letters carefully coordinated with a valve chart.
 2. Valve tags shall be color coded 0.032" anodized aluminum tags, with engraved letters similar to Seton S Type 250-BL or approved equal.
 - a. Plumbing tags shall be square 2" x 2" similar to Seton 42769.
 - b. Lettering shall be ¼" high for type service and ½" for valve number. Tag shall indicate service and valve number.



- c. Each service shall be a different color.
 3. Tag shall be attached to valves with chain similar to Seton No 16 stainless steel jack chain.
 4. Whenever a valve is above a hung ceiling, the valve tag shall be located immediately above the hung ceiling.
- vii. Furnish a minimum of two (2) typed valve lists
 1. Each framed under Plexiglas. Each chart shall be enclosed in an approved 0.015" thick plastic closure for permanent protection.
 2. Valve numbers shall correspond to those indicated on the Record Drawings and on the printed valve lists.
 3. The printed list shall include the valve number, location and purpose of each valve.
 4. It shall state other necessary information such as the required opening or closing of another valve when one valve is to be opened or closed.
 5. Printed framed valve lists shall be displayed in each Mechanical Room or in a location designated by the Owner.
- viii. Valve Data Base
 1. Provide a valve data base for all valves to operate on the building computer.
 2. Every valve shall include:
 - a. Tag Number
 - b. Service (cold water, etc.)
 - c. Size
 - d. Operation
 - e. Location
 - f. Manufacture
 - g. Model number



h. Submittal reference

3. Materials

a. Pipe labels shall be a UV-resistant indoor/outdoor vinyl.

i. Pipe Marking Color

1. Pipe labels should indicate both the contents of the pipe and its direction of flow. Arrows at one or both ends indicate flow; the contents are indicated by text and by a standard color scheme.

ii. Pipe Marker Size Chart

1. Pipe diameter determines the appropriate label and text sizes, as shown in the following table:

Outside Pipe Diameter (including insulation)		Minimum Length of Label Color Field		Minimum Letter Height	
Inches	mm	Inches	mm	Inches	mm
.75 – 1.25	19 – 32	8	203	.5	13
1.5 – 2	38 – 51	8	203	.75	19
2.5 – 6	64 – 152	12	305	1.25	32
8 – 10	203 – 254	24	610	2.5	64
>10	>254	32	813	3.5	89

iii. Pipe Label Components

1. Require Items

- a. System name
- b. Flow direction arrows on both ends
- c. Text: “Configuration Controlled System DO NOT ALTER HMS Facilities”
- d. Two Barcodes and Asset Numbers

iv. Pipe Label Placement



1. Labels should be positioned on the pipes so they can be easily read. Proper label placement is on the lower side of the pipe if the employee has to look up to the pipe, on the upper side of the pipe if the employee has to look down towards the pipe, or directly facing the employee if on the same level as the pipe. Labels should be located near valves, branches, where a change in direction occurs, on entry/re-entry points through walls or floors, and on straight segments with spacing between labels that allows for easy identification approximately every 25-50 feet.

v. Asset Label Standards

Convention:

X – SYS TYP - #####

X = Building

SYS = System

TYP = Asset Type

= Sequential Asset Number



System	Color	Description
HHW	Grey	Heating Hot Water
CHW	Green	Chilled Water
STM	Yellow	Steam
NG	Yellow	Natural Gas
PCW	Green	Potable Cold Water
PHW	Green	Potable Hot Water
NPHW	Green	Non-Potable Hot Water
NPCW	Green	Non-Potable Cold Water
RODI	Grey	High Purity Water
TW		Tower Water
HRW		Heat Recovery
FPW	Red	Fire Protection Water
CD	Orange	CO2
STC	Yellow	Steam Condensate
VAC	Black	Vacuum
CA	Blue	Compressed Air
SAN	Green	Sanitary
STRM	Green	Storm
FPA	Red	Fire Protection Agent

Building Letter	Description
A	Gordon Hall
B	Goldenson
C	C Building
D	Armenise
E	TMEC
F	180 Longwood
K	Dental REB
L	L.H.R.R.B
M	S.G. Mudd
P	HIM
Q	Warren Alpert
S	NRB
T	Dental Main
V	Vanderbilt
W	Countway
QUAD	HMS Quadrangle



Asset Type	Description
PIP	Pipe
VLV	Valve
HX	Heat Exchanger
PMP	Pump
TNK	Tank


22 1110 – Plumbing Valves

1. Water Valves

- a. Isolation/shut-off valves 3" and smaller shall be all bronze ball valves Watts Series B-6000, Apollo 77-200, Nibco 585-70, Hammond 8501 or Milwaukee BA100, full port Teflon seated ball and 2-piece valve body designed for 600 psi water.
- b. Isolation/shut-off valves 4" and larger shall be NibcoF-510-S6-R-66FS, F-515-S6-F-66-FS, F-530-S6-R-66-FS or Watts Series G4000 and G4000 M1 bronze fitted ball valves, flanged ends, iron body, 200 psi WOG, .
- c. Drain valves shall consist of ball valve with threaded cap. Provide at all low points in water piping system and at the base of all risers so that entire system may be drained, Apollo 78-103, Nibco 585-70 HC or Hammond 8501.
- d. Check valves 3" and smaller shall be Nibco S-413 –W, solder end, bronze body swing check, bronze disk, 200 psi WOG.
- e. Check valves larger than 4" shall be Watts Series 411, Nibco F-918B or Hammond IR1124, flanged end, iron body with epoxy coated trim, swing check, 200 psi WOG.
- f. Balancing valves for hot water circulation shall be Circuit Setter type, Armstrong, B&G, Nibco or approved equal with memory stop and calibrated nameplate. Combination shut-off and balancing valves are unacceptable.

2. Drainage Valves

- a. Ball valves on sewage and drainage ejector discharge piping shall be Nibco F-510-S6-R-66FS, F-515-S6-F-66-FS, F-530-S6-R-66-FS or Watts Series G4000 and G4000M1, flanged ends, 150 psi.
- b. Check valves on sewage and drainage ejector discharge piping shall be Kennedy 106LW, Nibco F-918L+W or Hammond IR1124LW, iron body, flanged ends, bronze disc with lever and weight.
- c. Gate valves for special waste ejector discharge shall be ASAHI/America, polypropylene, flanged ends with EPDM seals, bubble tight, quick opening valve, non-rising stem, 100 psi.

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- d. Check valves for special waste ejector discharge shall be ASAHI/America, polypropylene, flanged ends, with EPDM seals and seats, top entry, vertical or horizontal orientation.
- e. Backwater valves J.R. Smith #7012 cast iron, bronze mounted, hub end, exterior shall be waterproofed, bolted and extended cover to suit finish floor or grade.

3. Mixing Valves

- a. Provide at each hot water heating system a master thermostatic mixing valve. The units shall be thermostatic controllers with check stops, strainers, outlet thermometer, volume control and chrome finish as detailed on the drawings. Lawler Series #800 high/low mixing valve, (#805-86108-05 for flow rates of 100 GPM at 10 PSID, #802-86008-05 for flow rates of 40 GPM at 10 PSID, #801-86208-05 for flow rates of 25 GPM at 10 PSID). Contact manufacturer for flow rates over 100 GPM. Leonard, Symmons, Powers or approved equal.
- b. Emergency station (shower and eye/facewash) mixing valve shall be Lawler 911 E-85808-01 or approved equal. The valve shall be capable of high and low flows, positive hot water shut-off, integral cold water by-pass, integral check stops, strainer, volume control, thermometer and control mechanism to fail open to full capacity flow of cold water in the event of either the hot water supply is shut down or thermostatic control failure. Leonard, Symmons, Powers or approved equal.
- c. Lavatories shall be provided with point of use mixing valves, Watts Model USG-B, Powers #480 or approved equal where required by code. Device shall comply with ASSE 1070 and shall have lock feature.

4. Natural Gas Valves

- a. Valves 3" and smaller shall be Apollo Series 70-100-07, Nibco F.P. 600 or Hammond 8501-03, threaded bronze ball valve, 600 psi WOG.
- b. Valves 4" and larger shall be Rockwell Figure 143, semi-steel, lubricated plug valve, flanged ends, wrench operated, 200 psig WOG.
- c. Natural gas fire valves shall be Eiter Inner-Tite, flanged ends with spring activated fuse plug set to operate at 165°F. Shall conform to ANSI B16.1 and MSS-SP-71 Type 1.
- d. All natural gas valves shall be approved by the state and local codes.

5. Pressure Reducing valves

- a. The PRV shall be Watts ACV-115 Series. The valve shall maintain a constant downstream pressure regardless of demand fluctuations. The control shall be an adjustable, spring loaded, direct acting, normally open, diaphragm valve designed to permit flow when controlled pressure is less than the spring setting. The control system shall consist of an

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adjustable opening speed needle valve and adjustable closing speed flow control valve. The specification shall note when valves 6" and larger are to be installed with the stem in a horizontal position.

- i. Provide pressure gauges and shut-off valves on inlet and outlet of all pressure reducing valves.

22 1120 Plumbing Piping

1. General

- a. All systems under this Section shall be provided with valves to permit complete and/or sectional control of the system. They shall be located to permit easy operation, replacement and repair. They shall be installed where shown on the drawings, or as herein specified. They shall be the product of the specified manufacturer.
- b. All equipment shall be installed with isolation valves for service shut off. Equipment shut off valves shall be screwed ends, grooved or flanged. If screwed ends are provided, a union between equipment and valve shall be provided.
- c. The Plumbing Subcontractor shall purchase (furnish and install), domestically-produced products for all systems when possible.

2. Water

- a. Cement Lined Ductile Iron Pipe and Fittings
 - i. Below Ground Water Service Piping (4" and Larger)
 - 1. Class 52 ductile iron pipe with cement lining, ANSI, AWWA C-A21.10, ANSI/AWWA C104-A21.4, ANSI C111-A21.11.
 - 2. Fittings and special castings shall be Class 250 cement lined ductile iron and shall conform to ANSI A21.10. And A21.11. Joints shall be made with push-on Tyton joints or screwed flanges and shall be rodded and clamped. Incoming water services shall be provided with two (2) Dresser model 38 or Megalug 1100 Series flexible couplings.
- b. Copper Tubing and Fittings
 - i. All Aboveground Potable and Non-Potable Water Systems
 - 1. Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead free solder.
 - 2. ProPress copper tubing will be acceptable for all piping 2" and smaller.



3. The Plumbing Subcontractor shall match existing (use the same material) which exists in the building they are working.
- c. Copper Tubing and Fittings
 - i. Type K Below Ground Water Systems (3" and Smaller)
 1. Tubing to be Type K, soft temper brazed joints with bituminous coating. Conforming to ASTM B88 and fittings conforming to ASME B16.22.
- d. Polypropylene Pipe and Fittings
 - i. All Aboveground and Below Ground Potable and Non-Potable Water Systems
 1. Pipe shall be manufactured from a PP-R-CT resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipe shall be made in an extrusion process. Domestic hot water shall contain a fiber layer (faser) to restrict thermal expansion. All pipe shall comply with the rated pressure requirements of ASTM F 2389. All pipe shall be certified by NSF International as complying with NSF 14, NSF 61 and ASTM F 2389 or CSA B137.11.
 2. PPR-CT
 3. Fittings shall be manufactured from a PP-R resin (Fusiolen) meeting the short-term properties and long-term strength requirements of ASTM F 2389. The fittings shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All fittings shall be certified by NSF International as complying with NSF 14, NSF 61 and ASTM F 2389 or CSA B137.11.
- e. The Plumbing Subcontractor shall match existing water piping material within building which he is working.
3. Waste & Vent
 - a. Hubless Cast Iron Soil Pipe and Fittings
 - i. Aboveground Soil, Waste, Vent and Rainwater Piping
 1. Hubless Cast Iron Soil Pipe: No-hub pipe with Husky SD-4000 soil pipe coupling manufactured by Anaheim Foundry, 4-band clamp. Sealing gasket shall be neoprene in accordance with ASTM C564, CISPI 301-75.



- b. Hub and Spigot Cast Iron Soil Pipe and Fittings
 - i. Below Ground Soil, Waste, Vent and Rainwater Piping
 - 1. Asphaltum coated, service weight, cast iron pipe and fittings with resilient neoprene push-on or lead and oakum joints, ASTM A72, ASTM C564-70.
 - 2. Resilient Neoprene gaskets for 4" and smaller shall be lubricated as per manufacturer's recommendations and for 5" and larger on adhesive type lubricant shall be used.
 - 3. PVC Plastic Pipe and Fittings
 - a. Below Ground Soil, Waste, Vent and Rainwater
 - i. Schedule 40, conforming to STM D4101 and D2665, solvent weld joint system as manufactured by Charlotte, G.F., Harvel or IPEX.
 - ii. Above Ground Soil, Waste, Vent and Rainwater Piping
 - 1. Service weight cast iron pipe and fittings with resilient neoprene push-on joints. ASTM A72, ASTM C564-70.
- c. Copper Tubing and Fittings
 - i. Waste and Vent Systems 2" and Smaller
 - 1. Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead free solder.
 - 2. Shall not be used for urinal waste piping which shall remain cast iron. May be used for sewage ejector and sump pump discharge piping.
- 4. Storm
 - a. Hubless Cast Iron Soil Pipe and Fittings
 - i. Aboveground Rainwater Piping
 - 1. Hubless Cast Iron Storm Pipe: No-hub pipe with Husky SD-4000 soil pipe coupling manufactured by Anaheim Foundry, 4-band clamp. Sealing gasket shall be neoprene in accordance with ASTM C564, CISPI 301-75.
 - b. Hub and Spigot Cast Iron Soil Pipe and Fittings



- i. Below Ground Soil Rainwater Piping
 - 1. Asphaltum coated, service weight, cast iron pipe and fittings with resilient neoprene push-on or lead and oakum joints, ASTM A72, ASTM C564-70.
 - 2. Resilient Neoprene gaskets for 4" and smaller shall be lubricated as per manufacturer's recommendations and for 5" and larger on adhesive type lubricant shall be used.
 - 3. PVC Plastic Pipe and Fittings
 - a. Below Ground Soil, Waste, Vent and Rainwater
 - i. Schedule 40, conforming to STM D4101 and D2665, solvent weld joint system as manufactured by Charlotte, G.F., Harvel or IPEX.
- ii. Above Ground Rainwater Piping
 - 1. Service weight cast iron pipe and fittings with resilient neoprene push-on joints. ASTM A72, ASTM C564-70.

5. Gas

- a. Schedule 40 Black Steel Pipe and Fittings
 - i. Black steel pipe Schedule 40 and conforming to ASTM A120-74 (seamless type). Fittings shall be black malleable iron screwed type conforming to ANSI B16.3-71 for pipe 2 1/2" and smaller.
 - ii. Pipe 3" and larger and for systems where pressure exceeds 14w.c. shall be welded with Schedule 40 socket welded forged steel fittings conforming to ASME B16.11.
 - iii. Gas piping dropping inside concrete block partitions shall be factory wrapped for corrosion protection.

22 1140 – Plumbing Specialties

- 1. Flanges and Unions
 - a. Flanges



- i. Flanges shall be companion type, faced and drilled for not less than 125# steam working pressure complete with necessary adapter, and shall be of size and material of adjacent piping.

b. Unions

- i. Provide union connections to fixtures and equipment. Union connections include compression fittings, grooved couplings, and flared fittings.
 - 1. Unions on copper piping shall be bronze minimum working pressure of 200 psi.
 - 2. Unions on steel and iron shall be ferrous ground joint brass to iron, rated for the working pressure of the system.

c. Dielectric Fittings

- i. Provide separation between copper and ferrous piping systems such as nipples, unions or flanges. Components shall be equal to Watts or Victaulic/Clearflow.

d. Solder

- i. Domestic water, waste and vent: 95-5 lead free, ASTM B32.

2. Sleeves, Plates and Escutcheons

- i. Refer to Section 220500.

3. Access Panels

- a. Group together valves, traps, cleanouts, etc., concealed in suspended ceilings, walls and furred spaces to reduce the number of access panels, but all valves must be freely accessible for maintenance.
- b. Furnish access panels of proper size to service all concealed traps, valves and cleanouts, but in no case less than 18" by 12" for valves, traps or cleanout, and 24" by 12" for (2) valves, traps or cleanouts, or more.

Panels shall be of the proper type for material in which they occur to be furnished by this Contractor and turned over to the trade in which they occur for installation by the particular trade Contractor. The exact number of panels shall be determined by the number, location and grouping of traps, valves and cleanouts which must be accessible for servicing and maintaining the plumbing systems. Panels below ceilings shall be key operated.



- c. Panels shall have flush doors with #14 USCG steel door and trim #16 USCG steel frame, metal wings for fitting into construction, concealed hinges, and screwdriver operated stainless steel cam lock. Panels shall be shop coated with (1) coat of zinc chromate primer. Valves above removable ceilings shall have tiles marked with tile clips by this Contractor for identification, properly labeled. Panels in toilet rooms adjacent to urinals shall be Type 302, 18 gauge, stainless steel. All locks shall be universal with all building access panels locks.

4. Insulation

- a. Scope: The following piping, fittings, and valves shall be insulated:
 - i. All interior water piping.
 - ii. Aboveground horizontal rain water piping past the elbow, down the vertical, including drain bodies.
 - iii. Water, rainwater waste piping in exterior furred ceiling spaces and overhangs.
 - iv. All piping insulation disturbed or removed as a result or renovation work.
 - v. All horizontal waste piping receiving cold water condensate.
 - vi. Handicap sinks and lavatory supply and waste piping.
- b. Materials: The following materials are specified:
 - i. Pipe Insulation: Fiberglass similar to Owens Corning, Manville, Certain-Teed.
 - ii. Fittings and Valves Insulation
 - 1. Molded or fabricated fitting covers of equal thickness and identical in composition to adjacent pipe insulation, equal to Zeston pre-molded covers. At fittings and valves, the insulation vapor barrier shall be continuous and unbroken.
 - iii. All materials, including vapor barrier jackets, adhesives, etc., shall be fire retardant and asbestos free.
- c. Insulation Thickness
 - i. The piping, fittings, and valves shall be insulated with the following minimum thicknesses:
 - 1. Hot water and circulation piping: 1" thick on 1/2" to 1-1/4" pipe



and 1-1/2" thick on 1-1/2" and larger pipe

- 2. Cold water piping: 1" thick
- 3. Rainwater Piping: 1" thick
- 4. Frost-Proofed Piping: 3" insulation, dual temperature fire retardant jacket

d. Finish

- i. Concealed or Exposed: All service vapor barrier jacket (ASJ Fiberglass 24) on all exposed and concealed horizontal rain water conductor and all exposed and concealed horizontal and vertical water piping, except where flexible tubing insulation is used which requires no vapor barrier. Fittings shall be finished with pre-molded fitting covers.

e. Handicapped Lavatories and Sinks

- i. Truebro Handi Lav-Guard, Brocar Products Trapwrap #C-500R or McGuire ProWrap insulation kit, 3-piece interlocking for "P" trap assembly and 2-piece kit for water supplies shall be white flexible vinyl insulation secured with nylon fasteners supplied.

5. Hose Bibbs and Wall Hydrants

a. Hose Bibbs

	Toilet Rooms and Finished Areas	Mechanical Areas
Type:	Wall Mounted	Wall Mounted
Service:	Cold Water	Cold Water
Finish:	Chrome Plated	Rough Chrome/Brass
Body:	Brass	Brass
Handle:	Loose Tee	Loose Tee
Outlet:	3/4" NPT	3/4" NPT
Vacuum Breaker:	Atmospheric	Atmospheric
Listings:	ASME A112.18 / CSA B125.1 ASSE 1011 (vacuum breaker)	
Manufacturer:		
Chicago	952-CP	998-XKRCF
T & S Brass	B-0722	B-0736
Woodford	40HT	40HT-RB
Speakman	SC-5911-IS	---



b. Wall Hydrant

	Exposed		Recessed Box			Ground	Post
Service:	Cold Water		Cold Water	Hot & Cold		Cold Water	Cold Water
Finish:	Chrome Plated		Nickel Bronze			Bronze	Varies
Body:	Brass		Bronze			Bronze	Bronze
Box or Casing:	N/A		Stainless steel or nickel bronze			Nickel bronze	Galv Steel or Alum
Handle:	Loose Tee		Loose Tee			Loose Tee	Loose Tee
Outlet:	3/4" NPT		3/4" NPT			3/4" NPT	3/4" NPT
Vacuum Breaker:	Atmospheric		Atmospheric			Atmospheric	Atmospheric**
Listings:*	ASME A112.18 / CSA B125.1, ASSE 1011 (vacuum breaker)						
Manufacturer:	Non-Freeze	Mild Climate	Non-Freeze	Mild Climate	Non-Freeze	Non-Freeze	Non-Freeze
JR Smith	5609QT	5618	5509QT	5519	5560QT	5810	5910
Zurn	Z1310	Z1333	Z1300	Z1330	Z1325	Z1360	Z1385
Josam	71350	71070	71300	71300	71650	71600	---
Mifab	MHY-16	MHY-30	MHY-26	MHY-35	MHY-45	MHY-60	MHY-65
Wade	8600	8607	8700	8707	8706	8800	8900
Woodford	67	74	B67	B74	HCB67	Y95	Y30

Notes:

a. *Wall hydrants are intended for irrigation purposes only. Does not meet NSF/ANSI-372 for Drinking Water.

b. **Non-freeze feature will not automatically function when vacuum breaker is specified. The vacuum breaker must be manually tripped to facilitate drainage of hydrant.

6. Backflow Preventors

a. Acceptable Manufacturers and requirements

- i. Provide units approved by the authorities having jurisdiction, the following specified type is utilized to establish quality.
- ii. This Subcontractor shall make application in the name of the Owner for the installation of the backflow preventors and pay any resultant fees.

b. Reduced Pressure Backflow Preventors

- i. 2" and Smaller: Watts#LF0095-U-QT, Apollo or Febco lead-free bronze body, stainless steel check seats, unions, strainer and shutoff valves.
- ii. 2 1/2" and Larger: Watts #LF909W-S-OS&Y, Apollo or Febco lead-free with bronze seats and stainless steel trim, flanged, strainer and shutoff valves.
- iii. Provide an air gap fitting and full size indirect waste to floor drain.



- iv. Provide at Janitors' Closets and kitchen sinks using chemical dispensers.
- c. Provide test kit and spare parts for each type of installed unit. Provide inlet and outlet pressure gauges on units. Test kits shall be by the supplied manufacturer of units.
- d. Pressure Vacuum Breaker
 - i. Finished areas and locations unless otherwise noted: Watts #LF80MCQT, Apollo or Febco lead-free compact, chrome plated with integral shutoff valves.
 - ii. Mechanical areas and concealed locations: Watts #LF800MCQT, Apollo or Febco lead-free rough brass, replaceable seats with shutoff valves.

Note: Units must be installed a minimum of 12" above the highest downstream point of use, the unit will discharge water.

- e. Vacuum Breaker
 - i. For Hot or Cold Water: Watts #288A, Apollo #38-100 or Febco bronze, atmospheric vent, clean plated in exposed, finished areas. Note: Unit must be installed a minimum of 6" above the highest downstream point of use, the unit will discharge water.
- f. Ice Maker
 - i. Provide dual check in-line backflow preventor suitable for continuous pressure application. Watts LF7R, chrome plated and in-field testable.

7. Trap Primers and Water Hammer Arrestors

- a. J.R. Smith 5000 Series or Zurn Z-1700 Series - stainless steel "shoktrols" shall be installed on water supply lines to flush valves and to plumbing connected equipment equipped with fast acting valves to control water hammer. They shall be sized and selected in accordance with PDI Standard WH201 with access through wall access panels. Examples of such locations are as follows:
 - i. Flushometer valves
 - ii. Self-closing and metering faucets
 - iii. Prior to all pressure reducing valves
 - iv. Prior to all in-line solenoid valves
 - v. All laundry equipment



- vi. Sterilizer water supplies
- vii. Autoclaves
- viii. Hose spray pre-rinse
- ix. Glasswashers, cagewashers and similar equipment

b. Trap Primers

- i. Individual fixtures shall be primed by Precision Plumbing products, Inc., model Prime Rite, or Prime Pro. Device shall be machined brass with no springs or diaphragms. Mount 12" above trap to be primed.
- ii. Multiple fixtures shall be primed by Precision Plumbing Products, Model PT-4 through 30 and rated for quantity of traps to be served. The priming manifold shall be capable of supplying 2 oz. of water per trap supply at 20 psig every 24 hours. The device shall be factory assembled and prepiped complete with ball valve, water hammer arrestor, copper barrel hammer arrestor, copper barrel with piston, solenoid valve and 1/2" trap primer connections. Electronic connections include single point 120V, manual override switch breaker, timer with relay. Unit shall be factory tested and supplied in a wall mounted 16 gauge steel cabinet.
- iii. Install trap primers at all drains where trap seal is subject to evaporation, including open end drains (OEDs), mechanical room drains that do not receive indirect waste and toilet room floor drains.

8. Drainage Specialties

- a. Before setting any drains, cleanouts or wall plates, obtain from the General Contractor the exact information relative to the finished grades of the top of the drains, equipment locations and partition locations. All drainage specialties shall be of the size noted on the drawings and shall be equal to the figure numbers scheduled below. Drainage specialties may be J. R. Smith Company, Zurn, Wade, Josam or Mifab.
- b. Cleanouts
 - i. Cleanouts shall be furnished and installed at all locations required by applicable Codes, in accessible locations, at bottoms of soil and waste stacks, and other locations shown on the drawings and at each change of direction. All cleanouts shall be brought up to finished floor. Outlets shall be caulked or no hub type.



- ii. Cleanouts occurring in floors finished with quarry, ceramic tile, brick or granite shall be equipped with flush scoriated round bronze covers and frames as selected by Architect to coordinate with color of flooring, equal to J.R. Smith #4046. Covers shall be adjustable in height.
- iii. Cleanouts occurring in resilient tile floors or carpeted areas shall be equipped with flush round metal covers with frames, equal to J.R. Smith #4146 for tile and #4026 for carpet, with covers recessed to receive tile or carpet. Covers shall be adjustable in height.
- iv. Cleanouts occurring in floors finished with plain concrete shall be equipped with heavy duty flush scoriated round cast iron covers with round frame equal to J.R. Smith #4226. Covers shall be adjustable in height.
- v. Where cleanouts occur under the floors in unexcavated areas, they shall be brought up flush with the finish floor and fitted with a cover equal to J.R. Smith #4226 series, cast iron top.
- vi. Cleanouts occurring in floors protected with membrane waterproofing shall be same as above, except with integral membrane flashing clamping collar.
- vii. Cleanouts occurring in walls shall be equipped with flush smooth white metal covers, with 10 inch by 10 inch openings in square frames having anchoring lugs, equal to J.R. Smith #4735.
- viii. All otherwise exposed or accessible cleanouts shall be equal to J.R. Smith #4420 or #4531 as required to suit the conditions at each point of application.
- ix. Extension pieces and bodies of cleanouts shall be of cast iron and arranged to suit each condition of application.
- x. All metal specified above shall be solid "nickel-bronze" having high nickel content, appearance of satin chrome, and corrosion and wear resistance qualities greater than bronze.
- xi. Cleanouts shall be the full size of the pipelines to which they are directly connected, but need not be larger than 4 inches for pipe lines up to 10 inches, and shall be at least 6 inches for pipe lines 10 inches and up.
- xii. Grade cleanouts shall be J.R. Smith #4890 with inside caulk mounted in cast iron 12" square frame and cover LeBaron #S512.

c. Floor Drains (FD)



- i. All floor drains shall be the product of one manufacturer such as J.R. Smith, Wade, Josam, Zurn or Mifab.
- ii. Drains located in waterproofed floors of composition materials or of other kinds, shall be fitted with all required flanges, clamping devices and trim required to assure watertight conditions, and they shall be made watertight. Provide all other miscellaneous devices, as required, for a complete installation as approved by Architect.
 1. Type FD-A: Toilet Rooms, Shower Rooms and Plenums
 - a. J.R. Smith 2010-4-A-P075 floor and shower drain, duco-coated cast iron body with bottom outlet, combination invertible membrane clamp and adjustable collar with Type A polished, chrome plated strainer with flashing clamp device and trap primer.
 2. Type FD-B: Mechanical Rooms
 - a. J.R. Smith 2233-A-P075, 12" diameter top drain, duco-coated cast iron body with bottom outlet, seepage pan and combination membrane flushing clamp and frame for anti-tilt heavy duty slotted grate with suspended sediment bucket and trap primer.
 3. Type FD-_____: Environmental and Cold Rooms
 - a. J.R. Smith 3750-P075 floor drain, duco-coated cast iron body with bottom outlet, combination invertible membrane clamp and adjustable collar with polished nickel bronze strainer with oval funnel and trap primer.
 4. Type FD-_____: Darkrooms
 - a. J.R. Smith 2005-F37-P075 floor drain, acid resistant epoxy coated finish cast iron body with bottom outlet, combination invertible membrane clamp and adjustable collar with raised lip, polished, nickel bronze stainer and trap primer.
 5. Type FD-_____: Typical Lab Floors Glassware Washers and Sterilizers
 - a. J.R. Smith 9692-6-14-P075, 12" x 12" sanitary floor receptor 6" sump depth, 14 gauge, all Type 304 (CF8) stainless steel light duty with non-tile, loose set full grate with 2-1/2"



square center opening and anti-splash interior dome strainer and trap primer.

6. Type FD-_____: Vivarium Cage Washing Area and Tunnel Washing Area
 - a. J.R. Smith 9693-8, 12" x 12" x 8" deep, 14 gauge, all Type 304 (CF8) stainless steel light duty sani-floor receptor with non-tilt, loose set full grate with 1/2" square openings and anti-splash interior dome strainer.
7. Type FD-_____: Ice Machines
 - a. J.R. Smith 3510-P075 floor drain, duco-coated cast iron body with bottom outlet, combination invertible membrane clamp and adjustable collar with polished, nickel bronze strainer with 4" diameter funnel and trap primer.
8. Type FD-_____: Flushing Drain
 - a. J.R. Smith 2508, 25" square drain with acid-resistant coating, nickel bronze top and 1" non-potable cold water connection. Provide with Sloan Royal 110YC flush valve modified for bottom outlet and recessed in stainless steel cabinet.
9. Type FD-_____: Flushing Rim Drain
 - a. J.R. Smith 2500-H floor drain, duco-coated cast iron with acid-resistant coating and hinged bar grate.

d. Roof Drains (RD)

- i. All roof drains shall be the product of one manufacturer such as J.R. Smith, Wade, Josam or Zurn.
 1. Type RD-A: J.R. Smith 1010-RCU-AD, 16" diameter roof drain, duco-coated cast iron body with combination membrane flashing clamp/gravel guard and low silhouette aluminum dome, supplied with underdeck clamp and vandalproof secured top.
 2. Type ORD-A: J.R. Smith 1080-RCU-AD, 16" diameter roof drain with integral 2" dam, duco-coated cast iron body with combination membrane flashing clamp/gravel guard and low silhouette aluminum dome, supplied with underdeck clamp and vandalproof secured top.



3. Type RD-B: J.R. Smith 1560, 3" x 10" oblique scupper drain, plain bronze body with gasket, plain bronze grate with integral membrane.
4. Type RD-C (Green Roof): J.R. Smith 1080-RCU-AD duel inlet, 16" diameter roof drain, duco-coated cast iron body with wide flange membrane flashing clamp, perforated stainless steel extension, gravel stop and low silhouette aluminum dome, supplied with underdeck clamp and vandalproof secured top.
5. Type D: J.R. Smith 1083-C-E-R-C-U (flat) or 1085-ERC (sloped) controlled flow 15" diameter roof drain, dura-coated cast iron body with combination membrane flashing clamp/gravel guard with adjustable flow rate assembly and polyethylene dome, supplied with underdeck clamp and vandalproof secured top. Provide extension as required and sump receiver; see detail for weir openings. Provide where roof detention is required.
6. Type E: (Overflow): J.R. Smith 1045C 15" diameter roof drain with fixed PVC standpipe, adjustable extension, duco-cast iron body, flashing clamp, gravel stop, polyethylene dome. Provide sump receiver, underdeck clamp, and vandal proof dome.

7. Type F: Froet

- ii. Provide J.R. Smith 1710 vertical expansion joint at every drain location where the drain outlet piping connects directly to a vertical leader or when the horizontal offset is less than 10'.
- iii. Overflow roof drain discharge to grade shall be:
 1. J.R. Smith SQ-9-2039, stainless steel downspout cover suitable for piping from 3" to 15", stainless steel frame with hinged perforated strainer.

e. Backwater valves to be installed on gravity waste lines shall be as follows:

- i. Storm and Sanitary piping system valves shall be J.R. Smith 7022 line-size, coated cost iron body, hub inlet, spigot outlet, bronze threaded cover with automatic valve seat and flapper.
- ii. Laboratory waste shall be J.R. Smith 7022, line size similar to that specified for storm and sanitary systems, except enamel coated interior with ABS removable cover or approved equal.

9. Thermometers



- a. Thermometers shall be adjustable angle design of the separable well type and shall have a 9" cast aluminum case. The scale shall be white with black figures and graduations embossed on the scale. Thermometers shall be manufactured by Trerice Co., Ashcroft or Taylor Instrument.
- b. Thermometers shall be furnished complete with all necessary sockets, wells, connectors and accessories required for installation suitable for the service in which installed. Extension necks shall be furnished for insulated piping.
- c. Thermometers shall be furnished with the temperature ranges of 30° to 100°F for cold water, and of 30° to 240°F for hot water systems.

10. Pressure Gauges

- a. Pressure gauges shall have brass movement, aluminum case, double strength clear glass window with black embossed figures and graduations on a white dial face, with 1% accuracy of scale range. Gauges shall be manufactured by Trerice Co., Taylor Instrument, Wika or Ashcroft.
- b. Gauges shall be furnished with snubbers and needle valve shutoff valves.
- c. Gauges shall be 4 1/2" diameter furnished with ranges that will locate the intended pressure at the point of application approximately midpoint on the range scale. Gauges for natural gas, vacuum and similar low pressure systems shall be gauges specifically designed for low pressure applications.

11. Water Meters

- a. Meter shall be displacement type with cast iron casing and bronze trim. Meter shall consist of standard trimmings including an all bronze bypass meter with isolation valves, bronze and stainless steel gears and spindles, strainer and flanged ends. Meter shall be fitted with ball valves, cast iron body and bronze trim. Meter shall meet all requirements of the local Water Department and shall be equipped with dry contacts for remote reading on the Building Automation System. Meters shall be provided on all systems as required by the Boston Water and Sewer Commission.

12. Gas and Water Metering

- a. Provide metering of natural gas services and domestic water for new building construction and mechanical systems renovations of existing buildings that will have significant natural gas or water loads; exceptions are for gas supplies to building emergency generators.
- b. Pulse outputs from the meters shall be wired back to the nearest accessible building electrical meter "DI-type".



- c. Outputs for remote reading of meters shall be via a dedicated telephone line connection to the meter.

13. Building Automation System

- a. The building automation system shall be furnished and installed under another Section of these specifications. This Subcontractor shall provide the tees, pipe wells, valves, and caps to allow the connection from the BAS system to the plumbing points required. The pH probes, moisture content meter and resistivity probe shall be provided for BAS tie-in. The following table itemizes the equipment and location of the type of device necessary to connect to the BAS system.

Service or Equipment	Pressure	Temperature	Flow	Trouble	Location
Water Meter			X		Basement
Water Heaters		X			Basement
Water Booster Pumps	X			X	Basement
Vacuum Pumps	X			X	Basement
Air Compressor	X			X	Basement
RO/DI	X		X	X	Basement
Ejectors				X	Basement
Animal Water System				X	Basement
pH Neutralization System				X	Basement
RO Reject System				X	Basement
Manifold Gas System				X	Basement

22 3000 – Plumbing Equipment

1. Steam-Fired Water Heaters

- a. Furnish and install as shown on plans in accordance with all codes and authorities having jurisdiction ____ water heater(s) Model _____, as manufactured by AERCO INTERNATIONAL, INC. or Patterson Kelley.
- b. Each heater shall be rated to heat ____ GPM of water from 40°F to 140 °F when supplied with _____ lbs/hr of saturated steam at _____ PSIG to the electronic control valve. Condensate discharge shall be 160 degrees F or less, utilizing a sub-cooling coil operating at 92% efficient.
- c. Heaters shall be Aerco B+11 or U-Tube Double Wall or PK Compact Water Heaters.

2. Domestic Water Boosters Pumps

- a. Variable Speed Packaged Pumping System



b. Variable Speed Packaged Pumping System with Integrated Variable Frequency Drive Motors

- i. Furnish and install a pre-fabricated and tested variable speed packaged pumping system to maintain constant water delivery pressure. Grundfos BoosterPaQ Model; System shall provide _____ GPM at _____ PSI, with a minimum suction pressure of _____ PSI. System shall be _____ V / _____ Phase.
- ii. Each pump (4) shall provide _____ GPM at _____ TDH; _____ HP. Allowed substitutions are Synchroflo and Canaris.
- iii. The packaged pump system shall be a standard product of a single pump manufacturer. The entire pump system including pumps and pump logic controller, shall be designed, built, and tested by the same manufacturer.
- iv. The complete packaged water booster pump system shall be certified and listed by UL (Category QCZJ – Packaged Pumping Systems) for conformance to U.S. and Canadian Standards.

c. Pumps shall be Grundfos or Synchroflo.

3. Hot Water Circulators

a. Work Included

- i. Contractor shall furnish and install Grundfos Magna3® stainless steel wet rotor in-line circulator pump, with integrated VFD and Integrated Temperature Sensor for domestic Hot water Re-Circulation in accordance with manufacturer's recommendations and plans. The Plumbing Subcontractor shall refer to the schedule on the drawings for exact model numbers and pump characteristics.

b. Wet Rotor Circulator Pumps for DHW Re-Circ

- i. Furnish and install variable speed Grundfos MAGNA3 pump as per plans and pump schedule.

4. Point-of-Use Water Heater

- a. Provide unit equal to Eemax _____, _____ kW (wall mounted, undercounter), and provide up to 180°F water temperature.
- b. The unit shall include the following:
 - i. Two (2) heating modules.
 - ii. Replaceable filter.



- iii. 3/4" connections.
 - iv. Maximum operating temperature of 180°F.
5. All water heaters shall be lead free.

22 4000 – Plumbing Fixtures

1. Water Closets

- a. Refer to schedule on drawings for fixture types and model numbers.
 - i. Water closets shall be elongated, wall hung vitreous china, 1.1 GPF to 1.6 GPF, siphon jet with 1-1/2" top spud and cast iron nipples equal to American Standard or AFWall Millennium Model 2257.101.
 - ii. Flushometer valve shall be exposed chrome plated, manual dual flush, sensor operated battery-powered, 1" I.P.S. screwdriver angle stop, protective cap with set screw, adjustable tailpiece, vacuum breaker and spud coupling, set screw escutcheon at wall. Flushometer valve shall have a non-clogging piston operating with a self-cleaning debris screen. Flushometer shall be Model WES-111 Sloan, Zurn or Toto.
 - iii. Seats shall be heavy duty, institutional, solid plastic seat for elongated bowl, open front less cover with self-sustaining check hinge, Bemis Model 1655CT / 1655SSCT.
 - iv. Fixtures designated for handicapped use shall be installed in accordance with the Americans with Disabilities Act as well as state and local codes.

2. Urinals

- a. Refer to schedule on drawings for fixture types and model numbers.
 - i. Urinals shall be wall hung, vitreous china, 1.0 GPF, 0.125 GPF siphon jet with 3/4" top spud, American Standard or Washbrook Universal Model 6590.001.
 - ii. Flushometer valves shall be exposed, chrome plated, sensor operated, battery-powered, 3/4" I.P.S. screwdriver angle stop, protective cap with set screw, adjustable tailpiece, vacuum breaker and spud coupling, set screw escutcheon at wall. Flushometer valve shall have a non-clogging piston operating with a self-cleaning debris screen. Flushometer shall be Sloan Model 186 ES-S TMO.
 - iii. Fixtures designated for handicapped use shall be installed in accordance with the Americans with Disabilities Act as well as state and local codes.



3. Lavatories

- a. Refer to schedule on drawings for fixture types and model numbers.
 - i. Lavatories shall be vitreous china, self-rimming or wall hung and 8" faucet centers. American Standard or Ovalyn Undercounter Sink 0495.221, unglazed rim.
 - ii. The faucets shall be chrome plated, solar-operated. Equal to Sloan Solis EAF-275-ISM.
 - iii. Drains shall be chrome plated, cast brass grid drain. Equal to manufacturer of supplied fixture.
 - iv. Fixtures designated for handicapped use shall be installed in accordance with the Americans with Disabilities Act as well as state and local codes.

4. Emergency Showers and Eyewashers

- a. All showers and eyewashers shall comply with ANSI Z-358.
- b. Provide tepid water to all emergency equipment fixtures.
- c. Combination shower eyewash units in Mechanical Rooms shall be made of galvanized steel pipe and fittings and be equipped with ABS plastic shower heads, polished stainless steel pull rod, chrome-plated stay-open ball valves, two (2) spray heads and stainless steel bowl.
- d. Emergency fixtures shall be Speakman.
- e. All emergency fixtures shall be provided with a floor drain and trap primer.

5. Trim

- a. Fixture Trim and Accessories: Provide fixtures complete with fixture carrier, faucet, drain outlet, tailpiece, P-trap, and stops and supplies.
 - i. Finish: All trim exposed to view shall be polished chrome plated.
 - ii. P-Traps: Cast brass adjustable P-trap with cleanout plug, ground joint and 17 gauge minimum weight extension with escutcheon. Provide Chicago or McGuire #8090 1 1/4" by 1 1/2" on lavatories and #8089 1 1/2" by 1 1/2" on sinks.
 - iii. Drain Outlets: Provide drain outlet of the same manufacturer as the fixture, faucet trim or McGuire 155 with chrome plated cast brass plug with 17 gauge minimum weight tailpiece. Provide 1 1/4" tailpiece on lavatories and 1 1/2" on sinks.



- iv. Stops and Supplies: Chrome-plated brass with stop and loose key, Chicago or McGuire #170-LK, or # BV170-LK, escutcheon flexible riser. Refer to other Sections herein for information on transition between materials.
 - v. Joints between wall mounted fixtures and wall shall be sealed with caulk to match fixture color.
 - vi. All faucets, water coolers and drinking fountains shall be constructed of a lead free brass alloy and where applicable, shall be certified to comply with NSF 61 Section 9 Drinking Water Standard.
- b. Water Conservation: Provide water conserving fixtures and trim compliance with the following maximum water use requirements. Provide variable pressure flow controls on showers, sinks and lavatory faucets.
- i. Public Lavatories: 0.5 GPM for 9 second cycle
 - ii. Sinks (Low Flow): 0.5 GPM
 - iii. Water Closets (Low Flow): 1.28 GPF
 - iv. Urinals (Low Flow): 0.125 GPF
- c. Fixture Supports
- i. Acceptable Manufacturers: J.R. Smith, Zurn, Wade, or Josam.
 - ii. Provide floor mounted fixture support carriers for wall mounted fixtures including, but not limited to, water closets, urinals, lavatories, scrub sinks and clinical sinks. Fixture support shall support at least 250 lbs. for (5) minutes and 750 lbs. for bariatrics. Furnish complete with foot piece, all necessary bolts, nuts, washers and gaskets. The adjustable nipple for the water closets between the cast iron fitting and closet bowl shall be threaded cast iron. Secure all foot pieces to floor slab using four bolts per foot.
 - iii. Close coordination is required between the plumber and tile subcontractor in closet installation. Maintain 1/16" clearance between finished wall and back of closet and follow manufacturer's details in installing couplings to ensure tight seal at closet outlet. Closet hanging templates must be used.
 - 1. Water Closets: Zurn ZR-1204-CC, J.R. Smith 230-CI
 - 2. Lavatories: Zurn ZR-1231, J.R. Smith 700
 - 3. Urinals: Zurn Z-1222, J.R. Smith 637
 - 4. Bariatric Water Closets: Zurn Z-1203-N-XH-CC (750 lbs.)



Zurn Z-1203-N-XB-CC (1000 lbs.)

6. Sustainable Design Initiatives

- a. The project has been registered under the USGBC LEED – NC Version 2.2 Green Building Rating System. Contractor responsibilities relative to the LEED Certification process in general and credit documentation in particular are defined in Division 1.
- b. Plumbing systems and equipment with particular emphasis on sustainable design and integral to LEED Certification include, but are not limited to, the following:
 - i. Premium Efficient Motors
 - ii. Low Flow Plumbing Fixtures
 - iii. Low VOC Sealants and Adhesives
 - iv. Construction IAQ Management Plan

26 6000 – Laboratory Plumbing systems

- 1. Regulators
- 2. Manifolds
 - a. Provide specialty gas manifolds as indicated on the drawings. Manifolds shall be as manufactured by Spectra Gases, Western Enterprise or Middlesex Gases. Manifolds shall provide continuous supply of gas from multiple sources, the manifolds shall be provided with automatic changeover with dual in-line regulators and a line regulator to control the delivery pressure. An alarm switch shall be provided within the manifold case and shall be capable of remote alarms. Manifolds shall be provided with flexible stainless steel braided pigtails with check valves, shut-off valves, and individual header valves with handle grips at each cylinder.
 - b. The manifold for the CO2 system shall be the same except provided with cryogenic pigtails.
 - c. Manifolds shall be as follows:
 - i. Nitrogen:
Western Enterprises Model DS1000-7-X-Y-Z
 - ii. Helium:
Western Enterprises Model DS1000-5-X-Y-Z
 - iii. Argon:



Western Enterprises Model DS1000-3-X-Y-Z

- iv. Oxygen:
Western Enterprises Model DS1000-9-X-Y-Z
- v. CO2:
Western Enterprises Model DS1000-4-X-Y-Z

3. Outlets

- a. Refer to schedules on drawings for fitting types and model numbers.
 - i. Lab fittings shall be chrome plated, indexed for specific service, pressure rated to meet requirements of specific service. All natural gas turrets shall be supplied with an integral check valve. Equal to Chicagofaucets.
- b. Furnish and install the following sink fittings, laboratory outlets, fixtures, etc."
 - i. C - Cold Water Outlet - Peninsula Bench - CS – Drop
Chicago No. 937-E22 non-domestic cold water outlet
 - ii. G - Gas Outlets - Peninsula Bench – Drop
Two Chicago No. 909-C gas outlets - back to back
 - iii. V - Vacuum Outlets - Peninsula Bench – Drop
Two Chicago No. 987-LF-907 vacuum outlets - back to back
 - iv. A - Compressed Air Outlets - Peninsula Bench – Drop
Two Chicago No. 907 compressed air outlets - back to back
 - v. N - Nitrogen Outlet - Peninsula Bench – Drop
Two Chicago No. 937CH nitrogen outlets - back to back
 - vi. C1 Cold Water Faucet - Wall Bench - CS – Deck Mounted
Chicago 928-VB water faucet
 - vii. G1 Gas Outlet - Wall Bench – Deck Mounted
Chicago No. 980 WS-909C single gas outlet
Chicago No. 981 WS-909C double gas outlet
 - viii. V1 Vacuum Outlet - Wall Bench – Deck Mounted
Chicago No. 980 WS-907 single vacuum outlet
Chicago No. 981 WS-907 double vacuum outlet.
 - ix. A1 Compressed Air Outlet - Wall Bench – Deck Mounted
Chicago No. 980 WS-907 single compressed air outlet
Chicago No. 981 WS-907 double compressed air outlet



- x. N1 Nitrogen Outlet - Wall Bench – Deck Mounted
Chicago No. 980 WS -937 single nitrogen outlet
Chicago No. 981 WS -937 double nitrogen outlet
- xi. RO - Reverse Osmosis Faucet – Deck Mounted
Orion GNF30-STD or GNF30-VB deionized deck mounted water faucet.
- xii. Provide Chicago Quick Connects where required.

4. Source Equipment

a. Vacuum Pumps

- i. Provide complete factory-assembled and pre-tested laboratory / medical / dental medical vacuum pump system consisting of oil less rotary vane, screw or claw vacuum pumps by Medaes, Beacon Medical or approved equal and in compliance with NFPA 99.
- ii. Sihi vacuum pumps shall be considered for laboratories using chemicals in the vacuum system.

b. Air Compressor System

- i. Provide complete factory-assembled and pre-tested laboratory / medical air compressor system in compliance with NFPA 99. System shall consist of oil-less compressors, motors, control panel, receiving tank, air dryers, duplex filter assembly cabinet, pressure regulating valves, and dewpoint/carbon monoxide monitor. System shall be Medaes MedPlus, Beacon Medical, Squire Cogswell or approved equal.
- ii. Capacity: Provide compressor capacities, motor sizes, receiver, filters, and regulators equal to Medaes # _____.
- iii. Compressors shall be oil-less rotary scroll, oil-less reciprocating, oil-free rotary tooth or oil-flooded screw.

c. pH Adjustment System

- i. The laboratory waste pH Neutralization System shall be supplied as a complete, integrated process system by a single supplier, skid mounted, preassembled and pre-tested prior to delivery to the site. The system shall be delivered as a complete skid with all inter connecting piping, signal wiring, and power wiring installed and tested prior to delivery. The system shall be manufactured by PPM or Practical Applications, Inc.
- ii. The laboratory waste pH Neutralization system shall be a two-stage system with two continuous, stirred tank reactors in series. Each tank stage shall have bi-



directional pH control and have equal treatment capacity in order to provide full redundancy. Laboratory waste shall flow into the first tank from the laboratory drain system. After mixing and treatment, the wastewater shall flow into the second tank for additional treatment as necessary and then be discharged to the sewer. The pH of the final treated effluent wastewater shall be monitored independently and shall be recorded on a circular chart recorder. The flow rate and total cumulative flow of the final treated effluent shall be monitored and shall be recorded on the same circular chart recorder. The system shall be provided with a minimum of three (3) 3/8" sampling spigots installed on the effluent discharge. Spigots shall be located so that they are accessible from the floor.

d. Reverse Osmosis Deionized Water System

i. Water Purification Equipment

1. Provide a central pure water system capable of generating _____gallons of product in 8 hours (_____ gallons per day), based upon cold municipal potable feed water with no tempering, with _____ gallons of storage by using two (2) _____ gallon storage tanks. The system shall be factory wired. All skids shall have local disconnects at pumps and devices requiring starters for 460 VAC power. 110 VAC or 24 V signals from the central monitoring and control panel located on the distribution pump skid shall signal local stagers, starters, and VFDs. This Contractor shall be responsible for all required interconnecting wiring and piping between the skids.

System shall be by Arion Water Systems and shall consist of, but not limited to, the following major components as required to provide the level of water quality specified. The specification is provided with references to Arion. The panel is to be wired to provide a single point connection for service from Section 260530. The contract shall include all components as required to provide a completely operational system as outlined by these documents and verified by the vendors detailed P, & I, D drawings.

2. Major Equipment

- a. (1) Multimedia filter
- b. (1) Duplex Water softener with brine tank
- c. (1) Carbon filter
- d. (1) Pre-RO UV sterilizer and carbon filter recirculation system (1) Reverse osmosis system unit



- e. (2) _____ gallon conical bottom RO product storage tanks with stands, with accessories
 - f. (1) Distribution pump skid, with mixed bed deionizers, resin traps, UV, and 0.2 micron filters
 - g. (1) Reject transfer pump skid
 - h. (1) PLC control Panel
 - i. Instrumentation
3. Performance requirements: The system shall generate water equal to the following, measured at the effluent of the distribution skid outlet:
- a. Silicate (SiO₂): ≤ 0.1 mg/l
 - b. Resistivity: greater than 16.0 Megohm-cm
 - c. Bacteria Content: less than 1000 CFU/ml
4. Complete documentation shall be provided with the pure water equipment. Documentation shall include but not limited to the following:
5. Detailed P&ID Drawing
- a. Valves tag numbers
 - b. Instruments tag numbers
 - c. Alarms
 - d. Pipe sizing and material of construction
 - e. Skid limitations
 - f. Plan of component layout
 - g. Written sequence of operation
6. Mechanical Assemblies of all Skids
- a. Dimensions
 - b. Major components highlighted



- c. Bill of materials
- 7. Control Panel Layout
 - a. Lights, switches and instrument plaques
 - b. Back panel layout
- 8. Manufacture Catalog Data Sheets
 - a. Major components
- 9. Testing
 - a. Hydrostatic of all equipment
 - b. Control panel checkout
- 10. System shall be a fully recirculated piping system.
- e. RO Reject System
 - i. System shall be by Arion Water Inc. and shall include the following:
 - ii. Reject Transfer Storage Tank
 - 1. Provide one (1) _____ gallon vertical, flat bottom, cylindrical tank
Specifications
Dimensions ___" diameter x ___" height approx. (without accessories)
Provide all nozzles. Provide level switches on tank.
Access:
Top Manway or 12" minimum access port
Material of construction: Polyethylene
Auxiliary Equipment
Level switches
High Level - shutdown city water valve
Low level - fill tank
Low level – shut down transfer pumps
 - a. Provide one (1) two-way valve located on the reject storage tank. The purpose of this valve shall be to fill the tank with city water if sufficient reject water is not available. The valve shall be of PVC construction and be electrically actuated.
 - i. Tanks and tank accessories will be shipped loose for field installation



iii. Reject Transfer Pump Skid

1. General Description

a. To transfer reject the water that has been stored, a ____ GPM duplex pump skid is to be provided. The pump skid shall be shipped completely pre-piped. One VFD (with pressure transmitter and PID loop control) per each pump shall be provided, and include a disconnect in its own dedicated NEMA 12 enclosure to allow servicing of either pump without interrupting service flow. Deliver ____ psig at final skid discharge. The pump skid shall be built with flanged inlet and outlet connections to mate directly to adjoining tanks and other supplied equipment. One pump shall operate as a backup. Provisions shall be made to alternate the back-up pump on a time basis, in accordance with manufacturer's recommendations for best performance and longest life.

b. Pump quantity Two (2)
Pump type.....Multistage centrifugal
Design flow ____ GPM (per pump)
Design pressure ____ PSI (regulated, per pump)
Manufacturer..... Grundfos _____or Approved Equal
Materials of construction ..316L stainless steel (wetted surfaces)
Horsepower ____ HP
Phases3 phase
Voltage.....460 VAC
Components.....316 stainless steel

2. Skid, Valves and Piping

Frame Carbon steel
Paint..... Epoxy, polyurethane, or powder coated
Valves (≥ 2")..... Butterfly (EPDM/316SS internals)
Valves (< 2")..... Ball, PVC
Piping SCH 80 PVC, solvent welded

iv. Reject Transfer Bladder Tank and Instruments

1. Bladder Tank

a. A five gallon bladder tank shall be provided. The purpose of the tank is to allow the VFDs to go into automatic shutdown mode to save energy when no water is called for.

2. Instrumentation

Pressure indicators (1) 316SS, 2.5" face, liquid filled, 1-160 psig



Sample valves (1) PVC ball

f. Animal Watering System

i. The Plumbing Contractor shall be responsible for a complete and functional animal watering system (AWS). The system shall include all circuitry (conduit, cable, wire, boxes, etc.) for control wiring required. All wiring material shall comply with the AWS vendor requirements and shall be coordinated with all other trades. The Animal Watering System shall be by Edstrom.

ii. Edstrom Watchdog System

1. The Edstrom Watchdog System is a computer based data management, monitoring and control system specifically designed for laboratory animal facilities. The multi-tasking operating system allows simultaneous data collection, room task scheduling, alarm notification and report generation. The modular system design allows for addition of devices and sensors to meet the changing needs of the facility.

2. Animal Watering System Controller (AWSC)
Collect and process all data from sensors, provide user interface to view status, troubleshoot, set-up and activate control components. Store data in the event of communication loss with Watchdog server.

3. System Communications and Cabling
Applicable cabling required for specified communications to interconnect components of modular design system.

iii. Chlora-Flush Station (Model CFS-305)

1. General

a. The Chlora-Flush Station shall be a panel assembled self-contained unit designed for wall mounting. It will provide chlorinated water at an operating pressure of approximately 17 psi for flushing and sanitizing mobile rack manifolds. Both models are UL LISTED

iv. Recoil Hose Flush Station

1. The recoil hose flush station is to be a panel assembled, self-contained unit designed for wall-mounting. It shall provide a method to internally flush up to (6) detachable recoil hoses at one time. The flushing procedure involves connecting up to (6) recoil hoses to the flushing station and flushing them with water and then evacuating the hoses with compressed air. This may be accomplished automatically. Periodic



flushing may control bacterial growth in the recoil hoses. The unit is to be Edstrom Model No. 5480.

v. Portable Sanitizer

1. The portable sanitizer shall be a self-contained system capable of delivering a pre-mixed sanitizing solution into the room distribution piping via an injection point. The unit shall consist of a 20-gallon polyethylene reservoir tank mounted on a movable dolly and a submersible 1/8 HP pump with an 8'-0" long solution supply hose. The system will also include a cover mounted on/off switch, an interconnect station drain hose and a tank drain hose. The unit is to be Edstrom, Model No. P/N 15450-000.

vi. Pressure Reducing Stations

1. The Pressure Reducing Station is a panel assembly to provide animal drinking water at a normal operating pressure of 3-4 +/-1/2 psi with a minimum flow of one gallon per minute.

vii. Stainless Steel Room Distribution System

1. The stainless steel room distribution system is a water delivery piping system designed specifically for an animal automated drinking water system. The system operates normally at a low pressure of 3-5 psi, but is subjected to flushing pressures up to 50 psi.
 - a. This specification applies to the receiving, handling, storage, and installation of stainless steel tubing and fittings for an animal drinking water system.
 - b. Furnish all materials in accordance with this specification and manufacture in accordance with applicable codes and standards.
 - c. ANSI/ASTM Standard A450 stainless steel tubing.
 - d. Purchase the complete piping system from a single manufacturer. Factory cut and fabricate tubing to system designed lengths, electropolish and passivate and then cap and/or seal in a bag and suitably box for shipping protection. Individually bag each fitting and suitably box for shipping protection.



- e. Inspect shipping cartons upon delivery for damage and material cleanliness. Report promptly to the manufacturer any damaged material.
 - f. Handle tubing to avoid bending or damage. Keep materials clean and free from grease and oil. Store all tubing and fittings in their original package until ready to use.
 - g. Store all system material in an area segregated from other construction material. Choose a location inside a building protected from any corrosive atmosphere. Limit access to protect against physical damage, loss and contamination.
2. Room Distribution Piping and Fittings
Distributes water from a pressure reducing station in to and around each animal room and to flush drain points. Pressure rating is 200 psi minimum. Use piping/fitting design to allow mechanical dismantling for repair or replacement of individual components. Soldered, brazed or adhesive bonded joints are not permitted. Electropolish externally and passivate all water contact surfaces to attain a uniform oxide inactive surface film.
- a. Stainless steel welded tubing
 - i. .50" OD x .035" wall
 - ii. 316 L grade
 - b. Electropolish/passivation process
 - i. Electropolish in 135°F solution of 65% phosphoric - 35% sulfuric acid
 - ii. Passivate in 105°F solution of 20% nitric - 80% water
 - iii. Final rinse with 125°F Reverse Osmosis water to remove all chemical residues
 - iv. Electropolish and passivate after all fabrication and welding
 - c. Coupling, elbow, tee fittings
 - i. Clean Fitting or equivalent sanitary type
 - ii. 316 L grade stainless steel



- iii. ID: .43" to exactly match tubing ID
- iv. Electropolish both internally and externally and passivate in accordance with 2.1.2 to a finish of 32 RA or better on all water contact surfaces
- v. Joint Seal
 - 1. High grade FDA approved silicone
 - 2. Seal edge width: .05"
 - 3. ID: .43" for flush internal joint
- vi. Ferrule: 316 Stainless Steel
- vii. Retainer hex nut: 303 stainless steel

viii. Bottle Filling Station Model BFS-675

- 1. The Bottle Filling Station is a complete system for automatically filling a case of animal drinking water bottles with treated or untreated water. The bottle filling station accurately mixes a base treating solution into animal drinking water for chlorination, acidification or medication and dispenses the treated water through a manifold and nozzles into a case of water bottles. The station is designed with easy access to solution tank for refilling. Solution metering pump is positioned low on the frame for positive pump priming. Reservoir tank with cone bottom can be located on either side, back or remote to the fill table. Fill Station sides are removable for conveyor feed. Options are available for remote monitoring and report writing with V5-Watchdog connection.

5. Piping, Fittings and Joints

a. Polypropylene Piping

i. RODI Water System

- 1. Piping shall be SDR11 Beta Series wall thickness conforming to ASTM-2837 with butt fusion joints rated for 150 psi at 68°F as manufactured by Asahi or Orion.
- 2. If alternate manufacturer is submitted, it shall be the Contractor's responsibility to verify pipe sizes, pressure losses and velocities within the system. The Contractor will be required to submit his design prior to installation for review and approval.



- ii. Above Ground Laboratory Waste and Vent (Smaller than 3")
 - 1. Schedule 40 fire retardant, ASTM D4101, mechanical joint system as manufactured by Orion, IPEX / Enfield, G.F. Fuseal or Asahi.
- iii. Above Ground Laboratory Waste and Vent (3" and Larger)
 - 1. Schedule 40 flame retardant ASTM D4101, mechanical system as manufactured by Orion, IPEX / Enfield, G.F. Fuseal or Asahi.
- iv. Lab Waste Ejector Discharge
 - 1. SDR 11 flame-retardant copolymer polypropylene rated to 150 psi at 68°F conforming to ASTM D4101. Fittings shall be plain end, pressure pattern drainage type. Joints shall be socket fused conforming to ASTM D2657, George Fischer, Orion Asahi.
 - 2. Contractor shall submit all lab waste discharge piping components to the Massachusetts Plumbing Board for approval per 248 CMR Section 10.13 Massachusetts Plumbing Code. Documentation submitted to the MA Plumbing Board shall indicate chemical compatibility.
- v. Below Ground Laboratory Waste and Vent
 - 1. Schedule 40, ASTM D4101, electrofusion or socket fusion system as manufactured by George Fischer, Orion, IPEX / Enfield or Asahi.
- b. Durion Piping
 - i. Laboratory Waste and Vent at all glasswashers, autoclaves and cagewashers – provide 10' section of piping.
 - 1. Piping shall be high silica content Durion or approved equal. Joints shall be made with stainless steel compression mechanical joints or hub and spigot with lead and acid resistant packing.
- c. Laboratory and Specialty Gas Pipe and Fittings
 - i. Use for Compressed Air, Helium, Argon, Carbon Dioxide and Nitrogen
 - 1. All piping shall be seamless copper tubing, Type L hard temper, ASTM Designation B88 for assembly with braze joint fittings.
 - 2. Fittings for connecting copper tubing shall be standard weight, wrought copper, brass or bronze type. Fittings for copper tubing shall be wrought copper fittings, deep socket, designed expressly for brazing at temperature greater than 1000°F or may be brass or bronze.



3. Brazing Alloy: For assembling braze-joint fittings shall be Aircoils 45 or other silver brazing alloy of equivalent melting point and physical properties and shall conform to ANSI/AWS A5.8.
4. All pipe shall be prewashed expressly for oxygen use and delivered washed and capped. Piping shall be installed with a constant nitrogen purge.

d. Copper Tubing and Fittings

i. Vacuum Piping, Compressed Air Intake and Vacuum Exhaust

1. Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88 and ASME B16.22. All joints shall be soldered with ASME AWS/A5.8 lead free solder.

6. Valves

a. RODI Water Valves (Polypropylene)

- i. Diaphragm Valves: 1/2" to 2", polypropylene, allowable working pressure of 150 psi at 68°F water, spigot ends, EPDM diaphragm, position indicator, George Fischer Type 315PP, Asahi or Orion.
- ii. Diaphragm Valves: 2-1/2" and larger, polypropylene, allowable working pressure of 150 psi at 68°F water, flanged ends, ANSI Class 150, EPDM diaphragm, position indicator, George Fischer Type 317PP, Asahi or Orion.

b. Nitrogen Shutoff Valves (Stainless Steel Systems)

- i. 1/16" to 3/4" shall be all stainless steel with extended stems and CTFE seat, swage or compatible style ends equal to Whitey Series 40. 1" to 2" shall be swage or compatible style ends equal to Whitey Series 60.

c. Specialty Gas Shutoff Valves (Compressed Air, Vacuum, Helium, Argon Vacuum, Carbon Dioxide and Nitrogen)

- i. Ball valves shall be three piece bronze or brass body with chrome plated bronze or brass ball, Teflon seats and stem seal, full port designed with extension ends for brazing.
- ii. All valves except for vacuum shall be prepared for oxygen service. Valves to be rated for 400 psi and activated by 90 degree turn to full-on to full-off position, Watts B-6801 or Apollo.

d. RODI Pressure Regulator



- i. Pressure regulator shall be polypropylene with NPT threads. The valve shall be one piece body housing containing the inlet port, outlet port, valve seat and pressure orifice. The regulator shall have a piston with a fabric reinforced EPDM rolling diaphragm sensing the downstream pressure and providing for maximum sensitivity and control accuracy. The shaft connecting the piston and the valve seat assembly shall have a double U-cup seal for safety. The valve shall be as manufactured by Plast-O-Matic or George Fischer. Refer to the drawings for model numbers and pressure settings.

- e. RODI Backpressure Regulator
 - i. Backpressure regulator shall be polypropylene with NPT threads. The valve shall be of the inline porting design with a solid diaphragm backed by an elastomeric supporting diaphragm. The pressure adjusting bolt and lock nut shall be plastic. The valve shall have fail-dry safety design with a vented chamber between the Teflon diaphragm and the secondary U-cup seal. The valve shall be 100% individually factory tested and shall be as manufactured by Plast-O-Matic or George Fischer. Refer to the drawings for model numbers and pressure settings.

- f. Compressed Air Pressure Regulating Valve
 - i. High capacity diaphragm operated regulator with zinc body, aluminum spring cage, adjustment mechanism capable of maintaining a constant outlet pressure with wide variation in flow similar to Watts Model R-119.

- g. The Plumbing Subcontractor shall match existing piping systems for all Laboratory Plumbing Systems in each of the various buildings.



23 0500 – Existing Building HVAC Systems Description

Designer Note: Equipment data noted below is based on a combination of sources: HMS asset lists provided by HMS on 10/27/2016, a spreadsheet provided by Siemens controls on 9/21/2016, and various Project documents pertaining to specific buildings and equipment. When utilizing existing building HVAC systems to serve areas of renovation or new work, the design Engineer must confirm which systems serve that area and that the heating, cooling and airside capacity is sufficient to support the design.

1. Armenise Building

- a. Heating: MATEP Steam to PRV station; Steam HW converters (D-HHC-0001, 0002) located in D1 basement. HW pumps (H-HWP-0001, 0002 & H-HWP-0003, 0004) located in D1 basement, 0001, 0002 are equipped with VFD's, 003/0004 do not have VFD's. Steam converter control valves are DDC with pneumatic actuation.
- b. Cooling: MATEP fed Chilled water coils: CHW pumps (DCHWP0001, 0002) located in D2 basement & serve AC-1, AC-2 & MUA-2 in link plus D2 FCU's - 775 GPM, 25 HP, Single VFD w/ switch, CHW deny valve is DDC w/ pneumatic actuator
- c. Process Condenser Water: (2) pumps on starters (?). Bypass valve, emergency city water supply controlled by pneumatic actuation by pressure.
- d. Controls: Siemens
- e. AHUs:
 - i. D-HAC-0013: AC-1; Installed 2012; Lab space ventilation, 100% OA; 20,000 CFM, 55F SAT, 7.6" TSP Design.
 - ii. D-HAC-0006: AC-2 / RAF-1; Installed 2012; Amphitheatre conditioned supply air with return air through RAF-1; 7,500 CFM, 55F SAT, 6.1" TSP Design.
 - iii. D-MUA-0001: MA-1; Installed 2012; Fume hood make up air, 100% OA, heating only; 12,000 CFM 55F SAT, 8.35" TSP Design
 - iv. D-HAC-0012: AHU-10; Installed 2004; 6th Floor Walker Labs make up air, 100% OA; 7,500 CFM, 55F SAT, 6.0" TSP Design.
 - v. D-HAC-0011: AC-3; Installed ???; Lab make up air, 100% OA; 7,500 CFM, 65F LAT (RESET?).
 - vi. D-HAC-0004: AC-4; Installed ???; Fourth Floor Lab make up air, 100% OA; 6,150 CFM, 68F LAT (RESET?).
 - vii. D-HAC-0005: AC-5; Installed ???; Fifth Floor Lab make up air, 100% OA; 6,880 CFM, 65F LAT (RESET?).
 - viii. DHAC-0009: Installed 1971; 4th Floor Link; 1,800 CFM.
 - ix. DHAC-0010: Installed 2014; 4th Floor Link; 1,835 CFM.



2. Building C

- a. Heating: MATEP Steam PRV; There are (2) 250 GPM hot water pumps located in the basement which provide year round hot water to the terminal units located throughout the building through a 4-pipe distribution system. Pumps are redundant where if one fails the other provides standby duty.
- b. Cooling: MATEP fed Chilled water coils; There are (2) 1,175 GPM chilled water pumps located in the basement which provide year round chilled water to the terminal units located throughout the building through a 4-pipe distribution system. Pump set is redundant where if one fails the other provides standby duty.
- c. Controls: Siemens
- d. AHUs:
 - i. AC-1: Installed 1988; Lab Ventilation: 100% OA, Single fan, preheat, CHW coil, humidifier. Provides ventilation to all C1 lab and non-lab spaces not served by other dedicated units; 25,000 CFM / 100% OA
 - ii. MUA-1: Installed 1988; Fume Hood Make Up Air: 100% OA, Single fan, preheat, CHW coil, humidifier. Provides make up air ducted directly to hoods in C1. Supply air does not enter the spaces; 23,000 CFM / 100%OA.
 - iii. AC-2: Installed 2012; Lab Ventilation: 100% OA, 4 fan array with VFD's, 100% OA, CHW coil, steam preheat, humidifier. Provides ventilation to all C2 lab and non-lab spaces not served by other units scheduled below; 25,000 CFM / 100% OA.
 - iv. MUA-2: Installed 2012; Fume Hood MUA: 100% OA, 3 fan array with VFD's, 100% OA, steam preheat, humidifier. Provides make up air ducted directly to hoods in C2. Supply air does not enter the spaces; 23,000 CFM / 100%OA
 - v. AC-3: Installed 1988; 114 Lecture Hall: Recirculating air handler, CHW coil, no heating coil, no humidification. Serves Lecture hall 114; 2,640 CFM SA / 528 CFM OA.
 - vi. AC-3: Installed 1988; 114 Lecture Hall: Recirculating air handler, CHW coil, no heating coil, no humidification. Serves Lecture hall 114; CV / Draw Through; 2,640 CFM SA / 528 CFM OA.
 - vii. AC-6: Installed 2001; Lab 672 ICCB Fume Hoods & Ventilation: 100% MUA, VFD, Steam F&B preheat, Steam humidification, Chilled water coil, Steam reheat, Sized for future expansion. Running at 2,800 CFM; 4,000 CFM / 100% OA.
 - viii. MUA-7: Installed 2002; Hood MUA, Room 609 Clardy: 100% MUA, VFD, STM Face & bypass preheat, Steam humidifier, CHW, STM Reheat; 4,000 CFM / 100% OA.
 - ix. AHU-1: Installed 1991; Lab 123 - Hogle Generator: 100% RA (no OA intake), CHW W/ Electric preheat & Electric humidification; 1,500 CFM / 100%RA.

3. Countway Library

- a. Heating: MATEP Steam PRV; There are (2) 600 GPM hot water pumps serving all connected hot water loads in the building (HW reheat coils & radiant panels). The pumps are redundant and operate in a lead/lag/standby sequence. Both pumps located in basement. No VFD's.



- b. Cooling: MATEP Chilled water; There are (2) 900 GPM chilled water pumps serving all connected chilled water loads (AHU's & FCU's). The pumps are redundant and operate in a lead/lag/standby sequence. Both pumps located in basement and are equipped with VFD's.
- c. Controls: Siemens
- d. AHU's:
 - i. AHU-1: Installed 1998; Supply Air to Building: Recirculating Unit, Single fan, CHW coil, humidifier. Provides supply air to VAV's on all floors; 55,000 CFM / 18,000 CFM OA / 50F LAT / 8.0" TSP, 4.0" ESP.
 - ii. AHU-2: Installed 1998; Supply Air to Building: Recirculating Unit, Single fan, steam preheat coil, CHW coil, humidifier. Provides supply air to VAV's on all floors; 55,000 CFM / 18,000 CFM OA / 50F LAT / 8.0" TSP, 4.0" ESP
 - iii. AHU-3: Installed 1998; Rare Books Unit: Recirculating Unit, Single fan, steam preheat coil, CHW coil, HW reheat coil, humidifier. Provides supply air to rare books area in Lower Level 2; 14,900 CFM / 3,000 CFM OA / 50F LAT / 7.16" TSP, 3.0" ESP.
 - iv. AHU-4: Installed 1998; Rare Books Unit: Recirculating Unit, Single fan, steam preheat coil, CHW coil, HW reheat coil, humidifier. Provides supply air to rare books area in Lower Level 2; 14,900 CFM / 3,000 CFM OA / 50F LAT / 7.16" TSP, 3.0" ESP
 - v. AHU-5: Installed 1998; Supply Air to 6th Floor: Recirculating Unit, Single fan, steam preheat coil, CHW coil. Provides supply air to portion of 6th Floor; 7,000 CFM / 1,400 CFM OA / 53 F SAT / 5.44" TSP, 3.0" ESP.

4. Goldenson Building

- a. Heating: MATEP Steam PRV; HW converter (B-HHC-0001) located in B1 basement. HW pumps (B-HWP-0001, 0002 & H-HWP-0003, 0004) located in B1 basement and are not equipped with VFD's. Steam converter control valve is DDC with pneumatic actuation.
- b. Cooling: MATEP Chilled Water; Building served by (2) CHW pumps w/ VFD's, BCHQP-0001,0002, 1,000 GPM, 100 FT head, 40 HP, CHW deny valve is DDC, based on history of design documentation the pumps were installed in 1986.
- c. Controls: Siemens



d. AHUs

- i. B-HAC-0001: Amphitheater, recirculating unit with mixing dampers, no RAF, preheat, CHW, 1 Fan with VFD, DDC; SAT Reset based on return air temp; Air is preheated to 50F by duct mounted coil prior to entering unit.
- ii. B-HAC-0004, AHU-4: Link Ventilation, 100% OA, preheat, CHW, (2) Fans, VFD; SAT Reset based on OA; Air is preheated to 50F by duct mounted coil prior to entering unit.
- iii. B-MUA-0010: Preheat coils for B-HAC-0001 & B-HAC-0004;
- iv. B-MUA-0001: North B2 MUA, 100% OA, heating only, 2 fans w/ VFD; 9,000 CFM, SAT Reset based on OA, 2.87" TSP.
- v. B-MUA-0002; South B2 MUA, 100% OA, heating only, 2 fans w/ VFD; 8,500 CFM, SAT Reset based on OA, 2.87" TSP.
- vi. B-MUA-0003: North B1 MUA, 100% OA, heating only, 2 fans w/ VFD; 6,700 CFM, SAT Reset based on OA, 3.05" TSP;
- vii. B-MUA-0004: South B1 MUA, 100% OA, heating only, 2 fans w/ VFD; 7,300 CFM, SAT Reset based on OA, 3.3" TSP.
- viii. B-AHU-0001, SF-1: North B2 Ventilation, 100% OA, preheat, CHW, (2) Fans, VFD; 6,300 CFM, SAT Reset based on OA.
- ix. B-HAC-0002, SF-2: North B2 Ventilation, 100% OA, preheat, CHW, (2) Fans, VFD; 5,200 CFM, SAT Reset based on OA.
- x. B-HAC-0010, SF-3: South B2 Ventilation, 100% OA, preheat, CHW, Reheat, 1 Fan, no VFD; 5,000 CFM, SAT set point = 55F.
- xi. B-HAC-0005, SF-5; North B1 Ventilation, 100% OA, preheat, CHW, (2) Fans, VFD; 6,300 CFM, SAT =70F.
- xii. B-HAC-0006, SF-6: South B1 Ventilation, 100% OA, preheat, CHW, (2) Fans, VFD; 9,400 CFM, SAT = 68F.
- xiii. B-HAC-0008: Micro Lab 117 - Recirculating unit, no preheat, mixing box, DX cooling with adjacent water cooled condenser; Constant Volume.

5. Gordon Hall

- a. Heating: MATEP Steam PRV; Hot water provided to fan coil units and VAV reheat coils by heat exchanger A-HHC-001 and HW pumps A-HWP-0001,0002 located in basement MER 003U.



- b. Cooling: MATEP Chilled water; Chilled water provided to AHU's and fan coil units by CHW pumps A-CWP-0001,0002 located in basement MER 004. Pumps in good condition. (1) VFD installed to serve both pumps. 570 GPM, 60 FT, 20 HP. Deny valve is DDC. Controls are DDC.
 - c. Controls: Siemens, DDC
 - d. AHUs
 - i. A-HAC-0010 / AHU-10: Installed 2007; Basement & First Floor VAV terminals, supply & return fans with mixing box and economizer control; VAV
 - ii. AHU-2: Installed 1984; Suite 111 air handling system with supply & return fans and mixing box, cooling only (no heating coil); 4,000 CFM; VAV..
 - iii. AHU-3: Installed in 1978; Suite 213 air handling system with supply fan and mixing box, cooling only (no heating coil); CV Draw through; 4,000 CFM; CV draw through.
 - iv. AHU-7: Installed 1984; Suite 206 air handling system with supply fan and cooling only (no heating coil); 1,450 CFM; CV draw through.
 - v. AHU-8: Installed 1984; Suite 206 air handling system with supply fan and cooling only (no heating coil); 1,450 CFM; CV draw through
 - vi. AHU-13: Replaced in 2014?? (confirm); Suite 210 air handling system with supply fan and mixing box, cooling only (no heating coil); CFM unknown; VAV.
 - vii. HAC-0005: Installed in 1998; 100% ventilation air to spaces served by FCU's, steam PH, CHW coil; 2,000 CFM. CV draw-through.
 - viii. HAC-0006: Installed 1988; 100% ventilation air to spaces served by FCU's (Deans suite, conf rm and 3rd floor offices), steam PH, CHW coil; CV draw through.
 - ix. HAC-0001: Installed in 2001; Atrium skylight air handling system with supply fan and cooling only (no heating coil), mixing box; CV draw through.
 - x. HAC-0002: Installed in 2001; Atrium skylight air handling system with supply fan and cooling only (no heating coil), mixing box; CV draw through.
6. Harvard Institutes of Medicine (HIM)
- a. Heating: MATEP Steam PRV; Hot water provided to fan coil units and VAV reheat coils by heat exchanger and 2 redundant pumps. 2 additional pumps dedicated to vivarium reheat loop.



- b. Cooling: MATEP Chilled water fed to fan coil units by 2 redundant pumps; AHU coils fed by 2 redundant pumps.
 - c. Process cooling tower (80 tons??): serves process condenser water closed loop, 2 redundant pumps.
 - d. Controls: JCI BAS with Phoenix Lab Controls (original vintage).
 - e. AHUs
 - i. AHU-1-4 and EAHU-1-4: two tunnels (A&B sides) per supply and exhaust unit @ 45,000 cfm each (90,000 cfm / unit); 100% outside air AHU's with glycol heat recovery loop, LP steam preheat and humidifier, chilled water cooling.
 - ii. AHU-5&6: Serves Vivarium; 37,500 cfm each with glycol heat recovery loop, steam preheat and humidifier, chilled water cooling.
7. Laboratory for Human Reproduction and Reproductive Biology (LHRRB)
- a. Heating: MATEP steam to PRV station; There are (2) 200 GPM hot water pumps located in the basement which provide year round hot water to the terminal units located throughout the building through a 4-pipe distribution system. Pumps are redundant where if one fails the other provides standby duty.
 - b. Cooling: MATEP Chilled water; There is (1) 780 GPM chilled water pump serving AC units. and (1) 488 GPM CHW pump providing year round chilled water to the terminal units located throughout the building through a 4-pipe distribution system. Both pumps located in basement and are equipped with VFD's.
 - c. Process Cooling Loop: Two (2) 83 ton process condenser water closed-loop cooling towers located on the roof (one replaced in 2012). (2) Redundant pumps; Plate and frame heat exchanger (90 tons, Installed 2016) utilizes chilled water for backup/redundancy.
 - d. AHUs
 - i. AC-1: Installed 1996; Lab Ventilation: 100% OA, Single fan, preheat w F&B, CHW coil, humidifier. Provides ventilation to all labs on floors 1 through 5; CV / Draw Through; 16,000 CFM / 100% OA / 55F LAT / 3.5" TSP, 1.25"ESP.
 - ii. AC-3: Installed 1996; Lab Ventilation: 100% OA, Single fan, preheat w F&B, CHW coil, humidifier. Provides ventilation to all labs on floors 1 through 5; CV / Draw Through; 16,000 CFM / 100% OA.
 - iii. HV-1 / MAU-1: Installed 1996; Lab MUA: 100% OA, Single fan, preheat w F&B, humidifier. Provides ventilation to all labs on floors 1 through 5; CV / Draw Through; 12,000 CFM / 100% OA / 60F LAT (heating only) / 2.5" TSP.



- iv. AC-4: 6th Floor Lab Ventilation: 100% OA, Single fan, preheat, w F&B CHW coil, humidifier. Provides ventilation to all of the 6th Floor; CFM unknown.
 - e. Backup process water plate and frame heat exchanger: utilizes MATEP chilled water as heat rejection source from process loop. Manual changeover valves.
8. New Research Building (NRB)
- a. Heating: MATEP steam fed to PRV station; heat exchangers serve 3 separate pumped loops throughout the building (2 pumps serve Lab VAV reheat loop, 2 pumps serve perimeter radiation, and 2 pumps serve Vivarium Vav reheat loop).
 - b. Cooling: Chiller Plant located in sub-basement consists of (2) 2,000 ton and (1) 600 ton centrifugal chillers. (2) 1200 gpm and (3) 4,000 gpm pumps distribute to AHU coils and FCU's. (5) 873 ton Roof mounted cooling towers.
 - i. Plate and Frame heat exchanger utilizes winterized cooling towers that bypass chillers for free cooling of chilled water loop.
 - c. Process cooling: 150 ton closed loop process chiller and (2) pumps distributes 85 degree condenser water to all floors.
 - d. Controls: Siemens BAS with Phoenix Lab Controls
 - e. AHUs
 - i. AHU-1: located in 4th floor MER, service to Vivarium, 80,000 cfm.
 - ii. AHU-2: located in 4th Floor MER; service to Vivarium; 48,000 cfm.
 - iii. AHU-3: located in 4th Floor MER; Service to Lab floors; 105,000 cfm.
 - iv. AHU-4: located in 4th Floor MER; Service to Lab floors; 105,000 cfm.
 - v. AHU-5: located in Penthouse; Service to Lab floors; 90,000 cfm.
 - vi. AHU-6: located in Penthouse; Service to Lab floors; 90,000 cfm.
 - vii. AHU-7: located in Penthouse; Service to Lab floors; 95,000 cfm.
 - viii. AHU-8: located in Penthouse; Service to Lab floors; 75,000 cfm.
 - ix. AHU-9: located in Penthouse; Service to Lab floors; 75,000 cfm.
 - x. AHU-10. Capacity XX CFM: Mixed air unit. Electronic actuation. Chilled water coil. Reheat (LPS). Supply fans (2) on VFD's.
 - xi. AHU-11. Capacity XX CFM: Mixed air unit. Electronic actuation. Chilled water coil. Reheat (LPS). Supply and Return fans on VFD's.
 - xii. AHU-12. Capacity XX CFM: Mixed air unit. Electronic actuation. Chilled water coil. Reheat (LPS). Supply and Return fans on VFD's.
 - xiii. AHU-14. Capacity XX CFM: Return air unit. Electronic actuation. Chilled water coil. No heat.
 - xiv. AHU-15. Capacity XX CFM: Return air unit. Electronic actuation. Chilled water coil. No heat.
 - xv.



- f. Exhaust AHUs
 - i. EAHU-1: located in Penthouse, service to Vivarium, 80,000 cfm.
 - ii. EAHU-2: located in Penthouse; service to Vivarium; 48,000 cfm.
 - iii. EAHU-3: located in Penthouse; Service to Lab floors; 105,000 cfm.
 - iv. EAHU-4: located in Penthouse; Service to Lab floors; 105,000 cfm.
 - v. EAHU-5: located in Penthouse; Service to Lab floors; 90,000 cfm.
 - vi. EAHU-6: located in Penthouse; Service to Lab floors; 90,000 cfm.
 - vii. EAHU-7: located in Penthouse; Service to Lab floors; 95,000 cfm.
 - viii. EAHU-8: located in Penthouse; Service to Lab floors; 75,000 cfm.
 - ix. EAHU-9: located in Penthouse; Service to Lab floors; 75,000 cfm.

- 9. Seeley G Mudd
 - a. Heating: MATEP steam fed to PRV station; There are (2) 415 GPM Glycol HW pumps located in the basement which provide year round hot water to AHU-1,2 and MUA 4&5. Pumps are redundant where if one fails the other provides standby duty.

 - b. Cooling: MATEP chilled water; There is a new 370 CHW pump serving AHU's and (1) 450 GPM CHW pump providing year round chilled water to the terminal units located throughout the building through a 4-pipe distribution system. Both pumps located in basement and are equipped with VFD's.

 - c. Controls: Siemens

 - d. AHUs
 - i. AHU-1: Installed 2012; Lab Ventilation: 100% OA, Plenum fans, HW preheat, CHW coil, humidifier. Provides ventilation to most spaces; CV / Draw Through; 30,000 CFM / 100% OA / 55F LAT / 6.0" TSP, 3.00"ESP.

 - ii. AHU-2: Installed 2013; Lab Ventilation: 100% OA, Plenum fans, HW preheat, CHW coil, humidifier. Provides ventilation to most spaces; CV / Draw Through; 30,000 CFM / 100% OA / 55F LAT / 6.0" TSP, 3.00"ESP.

 - iii. AHU-4: Make up Air: 100% OA, Cent Fan, Preheat, CHW coil, Steam Humidifier; CV Draw Thru. DDC w/ pneumatics

 - iv. AHU-5: Make up Air: 100% OA, Cent Fan, Preheat, CHW coil, Steam Humidifier; CV Draw Thru. DDC w/ pneumatics

 - v. MA-6: Make up Air: 100% OA, Cent Fan, Preheat, CHW coil, Steam Humidifier; CV Draw Thru. DDC w/ pneumatics

 - vi. AHU-8: Make up Air: 100% OA, Cent Fan, Preheat, CHW coil, reheat coil, Steam Humidifier; CV / Draw Through.



- vii. AHU-9: Lab 606 Ventilation: 100% OA, Plenum fans, HW preheat, CHW coil, reheat coil, humidifier. Provides ventilation to Lab 606; CV / Draw Through preheat / Blow through CHW & Reheat.

10. Tosteson Medical Education Center (TMEC)

- a. Heating: MATEP steam fed to PRV station; Hot water is delivered to VAV reheat coils using a shell and tube heat exchanger (HX-2) and pump P-7, with DDC control valves. Hot water is delivered to radiation systems using a shell and tube heat exchanger (HX-1) and pump P-5, with pneumatic control valves. Neither of these pumps are equipped with VFD's. The two systems maintain minimum flow in the system using a differential pressure bypass control.
- b. Cooling: MATEP Chilled Water; There is (1) chilled water pump with VFD located in the link basement delivering chilled water from the MATEP supply & return mains to AHU chilled water coils in the building, return valve has pneumatic actuator. CWP-0001, 0002 (175 GPM, 40 FT, 5 HP) are located in basement #027A and provide CHW to fan coil units, return valve is DDC. In 2009 A fourth pump (65 GPM, 50 FT) was installed in room #004 to serve the supplemental CHW coils in Fourth Floor Gross Anatomy suite.
- c. Controls: Siemens
- d. AHUs:
 - i. AC-1 (HAC-0007): Installed 1991; Supply air to VAV Terminals serving Southern half of building. Including 50% of 4th Floor Gross Anatomy; VAV; 90,000 CFM / Supply TSP = 7.3" / Return TSP = 3.5".
 - ii. AC-2 (HAC-0008): Installed 1991; Supply air to VAV Terminals serving Northern half of building. Including 50% of 4th Floor Gross Anatomy and the basement Morgue; VAV; 90,000 CFM / Supply TSP = 7.3" / Return TSP = 3.5".
 - iii. AC-3 (HAC-0009): Installed 1991; Serves core atrium area. Also capable of 100% outside air and exhaust for smoke control. Refer to color coded drawings for areas served; CV; 30,000 CFM / Supply TSP = 3.5" / Return TSP = 1.5".
 - iv. HAC-0001 (AHU-1): Installed 2013; 100% OA ventilation for spaces served by FCU's; VAV; 3,600 CFM, TSP= 5.75".
 - v. HAC-0002 (AHU-2): Installed 2013; 100% OA ventilation for spaces served by FCU's; 3,300 CFM, TSP= 5.75".
 - vi. HAC-0003: Installed 2011??; 100% OA ventilation for spaces served by FCU's. Refer to AHU zoning plans for area covered; VAV; 6,000 CFM.



- vii. HAC-0004: Installed 2011??; Amphitheater. Recirculating system with supply fan, return fan and mixing box with economizer dampers & exhaust; VAV; 6,230 CFM, 4.0" TSP.
- viii. MUA-0001: Installed 1991; Booster fan provides fresh air to basement AHU's; VAV with controllable pitch blades; CFM unknown.

11. Vanderbilt Hall

- a. Heating: MATEP steam fed to PRV station. (4) steam to hot water Hex's.
- b. Cooling: MATEP Chilled Water; Chilled Water System: Pneumatic Control and actuation. (2) Deny valves. (2) Pumps on VFD's. (2) Pumps on starters
 - i. IT Department Chilled Water System: Pneumatic control and actuation. DP sensors. (2) Pumps on staged VFD's; CHW deny vlv pneumatic control, dp sensor, (2) staged pumps on VFDs.
- c. Building uses a two pipe changeover System that serves FCU and AHU coils through the same piping distribution loop.
- d. Controls: Siemens
- e. AHUs:
 - i. AHU-1. Capacity XX CFM: Mixed air unit. Preheat (HW) electronic control. Chilled water pneumatic control. Supply and return fans on starters.
 - ii. AHU-2. Capacity XX CFM: Mixed air unit. Preheat (HW) pneumatic control. Chilled water pneumatic control. Supply and return fans on starters.
 - iii. AHU-3. Capacity XX CFM: Mixed air unit. Preheat (HW) pneumatic control. Chilled water pneumatic control. Supply and return fans vanes on pneumatic control.
 - iv. AHU-5. Capacity XX CFM: 100% outside air unit. Bypass damper electronic control. DX cooling 2 stages. Reheat (LPS). Fan on VFD.

12. Warren Alpert Building (WAB)

- a. Heating: MATEP steam to PRV station; serves (3) shell and tube heat exchangers;
 - i. HX-1 Radiation: (2) Steam supply valves pneumatic control. (2) Pumps on starters. Bypass valve electronic actuation;
 - ii. HX-2 Animal: (2) Steam supply valves pneumatic control. (2) Pumps on starters. Bypass valve pneumatic actuation.
 - iii. HX-3 Lab Reheat: (2) Steam supply valves pneumatic control. (2) Pumps on starters. Bypass valve pneumatic actuation.
- b.



- c. Primary Cooling: MATEP chilled water with two redundant pumps located in basement serving FCU coils and AHU coils. Change-over piping arrangement for parallel local chiller plant.
 - d. Chiller Plant: Used during peak season; Four (4) 400 ton Rooftop Air cooled chillers (1600 tons total). Three (3) chilled water pumps in penthouse.
 - e. Process Cooling loop: Also serves Mudd, and C-building; One (1) 50 ton process condenser water closed loop cooling tower with two redundant pumps; Tower replaced in 2014. Plate and frame heat exchanger (2014) of same capacity utilizes chilled water for backup/redundancy.
 - f. AHUs: AHUs: 100% outside air AHU's with glycol heat recovery, steam preheat and humidifiers, chilled water cooling coils.
 - i. AHU-1-4 and EAHU-1-4: serve Labs 4 supply and exhaust units in penthouse; 70,000 cfm each.
 - ii. AHU-5&6 and EAHU-5&6: serves vivarium; 2supply units in basement, 2 exhaust units in penthouse; 23,000 cfm each.
 - iii. EAHU-1-6 exhaust fans replaced with fanwall (Huntair) in 2016. Each fan has VFD. Each unit has a harmonic filter.
 - g. Vivarium in basement (served by AHU-5&6 and EAHU-5&6)
 - h. Heat Recovery System: AHU/EAHU pumped glycol heat recovery system; (2) Pumps on starters. Mixing valve pneumatic control.
13. 158 Longwood Avenue: No information available.
14. 160-164 Longwood Avenue: Local Chillers, Local Boilers, Energy Recovery Unit, No further information available.
15. 180 Longwood Avenue:
- a. Heating: MATEP fed Steam PRV;
 - i. HX-1: Steam HEX. Pneumatic actuation. Outside air temperature controlled. Pumps on VFD's.
 - ii. HX- 2/3 ARC: High pressure steam HEX. Pneumatic actuation. Line TE controlled with reset by outside air temperature. Pumps staged on starters. DP sensor and bypass valve regulate pressure
 - b. Cooling: MATEP fed Chilled water coils. AHU Chilled Water: Pneumatic actuation. Pumps on VFD's with staged control; FCU Chilled Water: Pneumatic actuation. DP. Pumps on VFD's.



- c. Controls: Siemens
 - d. AHUs:
 - i. AHU-1. Capacity XX CFM: 100% Outside air unit, McQuay packaged unit. Preheat (LPS) control not on graphic. Mechanical cooling 2 staged compressors.
 - ii. AHU-2. Capacity XX CFM: 100% Outside air unit. Pneumatic actuation. Preheat (LPS) face and bypass. Chilled water coil. Fan on starter (?).
 - iii. AHU-4. Vivarium; Capacity XX CFM: Mixed air unit. Electronic actuation. Preheat (LPS). Chilled water coil. Humidifier is shut down and said not to be used.
 - e. Special: Data Center served by two (2) 10 ton DX Liebert Units.
 - f. New Emergency generator and Fuel storage system (Installed 2016).
16. 641 Huntington Avenue
- a. Heating: Steam Boiler System: Electronic actuation. 2 city water feed valves. 2 condensate pumps on starters. Hot Water System: DP sensor. (2) Pumps on VFD's.
 - b. Cooling: MATEP chilled water: Electronic actuation. Outside air temperature enabled. DP control with bypass valve. (2) Pumps on VFD's.
 - c. Controls: Siemens.
 - d. AHUs: No information available.
17. School of Dental Medicine
- a. Heating
 - i. HX-1: Steam HEX. Pneumatic control. Bypass valve. (2) Staged pumps on starters.
 - ii. 2nd Floor Radiation: Electronic mixing valve. (2) staged pumps on starters.
 - iii. HX-3: Steam HEX. Pneumatic control and actuation. Steam supply valves two position. Isolation valves. (2) pumps on starters
 - b. Cooling: MATEP chilled water; (2) pumps on VFDS; Deny valve; pneumatic control.
 - c. Controls: Siemens.



- d. AHUs:
 - i. AHU-1. Capacity XX CFM: Mixed air unit. Pneumatic control. Preheat (LPS). Chilled water coil. Supply and return fans on VFD's.
 - ii. AHU-2. Capacity XX CFM: Mixed air unit. Pneumatic control. No heat. Chilled water coil. Supply and return fans on VFD's.
 - iii. Malony AHU. Capacity XX CFM: Mixed air unit. Preheat (HW) electronic. Chilled water control not shown. Unit temperature controlled. Fan on starter.

18. Research and Education Building (REB)

- a. Heating: MATEP steam fed PRV; There are (2) 175 GPM hot water pumps serving all connected hot water loads in the building (HW radiation, radiant panels, reheat coils). The pumps are redundant and operate in a lead/lag/standby sequence. Both pumps located in basement and are equipped with VFD's.
- b. Cooling: MATEP Chilled water; There are (2) 600 GPM chilled water pumps serving all connected chilled water loads (AHU's & FCU's). The pumps are redundant and operate in a lead/lag/standby sequence. Both pumps located in basement and are equipped with VFD's.
- c. Controls: Siemens with Phoenix Lab Controls.
- d. AHUs
 - i. AHU-1: Installed 2004; Lab Ventilation: 100% OA, Single fan, heat recovery / preheat coil, CHW coil, and humidifier. Provides ventilation to all labs on floors 3 through 5; CV / Draw Through; 45,000 CFM / 100% OA / 55F LAT / 8.0" TSP, 3.0" ESP; Connected to AHU-2 for redundancy.
 - ii. AHU-2: Installed 2004; Lab Ventilation: Recirculating, Single fan, heat recovery / preheat coil, CHW coil, humidifier. Provides supply air to all office spaces on floors 1 through 5. Capable of 100% OA capacity to provide redundancy for lab ventilation (AHU-1); CV / Draw Through; 45,000 CFM / 100% OA / 55F LAT / 8.0" TSP, 3.0" ESP; Connected to AHU-1 for redundancy.
 - iii. HVU-1: Installed 2004; Smoke Control: 100% OA, Single fan, heat recovery / hot water preheat. Provides smoke control for stairwell vestibule.
 - iv. EAHU-1: Lab Exhaust and Heat Recovery: 100% Exhaust, Single fan, heat recovery coil. Recovers heat from exhaust air for OA intake preheat at AHU-1 & AHU-2; CV / Draw Through; 40,000 CFM / 100% OA / 55F LAT / 6.0" TSP, 3.0" ESP.



23 0501 – HVAC Design Criteria

1. Design Statement

- a. During the various design phases of this project, the Engineer will develop options and schemes for selection of the appropriate HVAC system. This approach will enable the entire Design Team (Owner, Architect and Engineer) to partake in the decision making process concerning the selection of the HVAC system and major equipment.
 - b. The new HVAC system shall have the following characteristics:
 - i. Energy Efficiency
 - ii. Flexibility for future changes.
 - iii. Durability; ease of maintenance.
 - iv. Reliability.
 - v. Redundancy (where required and cost effective, consult with HMS Project Manager).
 - vi. Future expansion (where required and cost effective, consult with HMS Project Manager)
 - vii. Cost effectiveness.
 - c. Design, layout and installation of equipment shall be in easily accessible locations, will provide for routine preventive maintenance and service for facilities personnel and outside contractors.
2. Design Phases: Each project shall be organized to follow a sequential design submission schedule that will include the following drawing sets. Design phases may be revised by HMS Project Manager dependent on scope and scale of the project.
- a. Review Owner Project Requirements with HMS Project Manager.
 - b. Conceptual narrative:
 - c. Schematic Design: Basis of design narrative, flow diagrams and major equipment layouts.
 - d. Design development:
 - e. Construction documents:



3. Energy

- a. The design team shall design all large projects to meet the Harvard Green Building Standards document. Smaller projects, while they may not pursue LEED certification, should also be designed to these HGBS standards.
- b. All projects should target a 20% improvement beyond current state energy standards (latest adopted ASHRAE 90.1 standard).
- c. Refer to Harvard Green Building Standards for additional requirements.

4. Codes, Standards and References

- a. The HVAC systems will be designed to comply with the latest volume or publication of following codes and standards:
 - i. Massachusetts State Building & Mechanical Codes
 - ii. City of Boston Article 37
 - iii. Massachusetts Stretch Energy Code.
 - iv. American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE)
 - v. United States Green Building Council (LEED)
 - vi. International Energy Conservation Code (IECC)
 - vii. Harvard Green Building Standards
 - viii. National Fire Protection Association (NFPA)
 - 1. NFPA 70 National Electrical Code
 - 2. NFPA 72 National Fire Alarm Code
 - 3. NFPA 101 Life Safety Code
 - ix. NFPA 110 Emergency and Standby Power Systems
 - x. Underwriters Laboratories (UL)
 - xi. Occupational Safety and Health Administration (OSHA)
 - xii. Environmental Protection Agency (EPA)
 - xiii. Massachusetts Department of Environmental Protection (DEP)



- xiv. American National Standards Institute (ANSI)
 - xv. American Society of Testing Materials (ASTM)
5. Outside Design Conditions:
- a. Summer: 91°F db/74°F wb for use in cooling coil selections)
 - b. Winter: -10°F db (for use in heating coil selections)
6. Ventilation Criteria
- a. Laboratories
 - i. One hundred percent of the air supplied to the Laboratory areas will be exhausted. Supply air quantities will be based upon heat loads, minimum dilution/ventilation requirements and/or required make-up air for exhaust systems, whichever is greater.
 - ii. High sensible heat load spaces (such as freezer farms, mas spec, and lab equipment corridors) shall be provided with minimum ventilation air and a separate sensible cooling, ceiling hung, unit. Sensible cooling units shall be fan coils and/or “chilled beam” induction units.
 - iii. Wet Laboratories (with fume hoods) shall be served by pressure-independent variable air volume (VAV) ventilation air control systems with a minimum of six (6) air changes per hour (ACPH) for dilution and/or removal of odors during occupied times. During unoccupied periods, the system shall have the capability to turn down to 2 ACPH (pending approval for EH&S authority). Air volume control shall be through a venturi type air valve.
 - 1. Fume hoods shall be exhausted using a variable volume pressure-independent, fast acting, venturi type air valve for a minimum face velocity of 90 feet per minute (fpm). Lower face velocities require EH&S review prior to approval. Airflow control valves shall be designed for chemical resistance appropriate for the application.
 - iv. Dry Laboratories (without fume hoods) shall be served by standard variable air volume (VAV) boxes or by venture valves, pending review by HMS project manager. The duct mains serving dry lab spaces shall be sized such that the lab could be converted to a wet lab in the future.
 - v. General Laboratory airflow rates will vary between 6 to 12 air changes per hour (ACH) or as required to meet the cooling loads and maintain space temperature and pressure setpoints while maintaining ASHRAE minimum ventilation requirements during occupied times.



- vi. Where cooling demand requires greater than 8 ACH chilled water fan coil units shall be used.
 - vii. Labs shall be sized with the capability for low turn down during unoccupied times. Space occupancy sensors (provided by electrical) shall dry contact outputs to the BAS for monitoring and automatic turndown of space VAV boxes where applicable.
 - viii. Air Quality Monitoring Systems, typically used to test the quality of air in a lab and automatically adjust the volume of air supplied to the lab, will not be acceptable.
 - ix. Air change per hour (ACPH) requirements will be based on exhaust device requirements and heat loads generated by equipment, people, lighting and solar heat gain.
- b. Office, Classroom and other non-Lab spaces will be designed in accordance with the latest ASHRAE Standard 62.1 for minimum ventilation air to occupied rooms.
 - c. Wherever possible 100% exhausted lab spaces and Office/classroom spaces suitable for air recirculation shall be served by separate air handling systems.
 - d. Air distribution systems will be designed to afford flexibility for future redesign, primarily by providing accessibility to duct systems throughout facility and, where feasible, by applying a modular layout of air distribution devices and by providing symmetry and uniformity to the branch duct layout.

7. Interior Space Design Conditions shall be designed in accordance with ASHRAE Standard 55 and the following table:

Space Type	Minimum O.A. Ventilation Rate	Summer Design		Winter Design		Pressurization	Minimum Supply Air Filtration (ASHRAE 52)	Remarks
		Max. Temp. (F)	Max. Relative Humidity (%rh)	Min. Temp. (F)	Min. Relative Humidity (%rh)			
Public Spaces and Office Areas								
Common Areas	Note 1	75	50%	68	20%-30%	Note 4	90%	-
Lobby	Note 1	75	50%	68	20%-30%	Note 4	90%	-
Offices	Note 1	75	50%	68	20%-30%	Note 4	90%	-



Conference Rooms	Note 1	75	50%	68	20%-30%	Note 4	90%	Note 7
Class Rooms	Note 1	75	50%	68	20%-30%	Note 4	90%	Note 7
Auditorium	Note 1	75	50%	68	20%-30%	Note 4	90%	-
Laboratory Spaces								
Open Lab	100%	75	50%	68	20%-30%	(--)	90%	-
Enclosed Equipment Room	Note 1	75	50%	68	20%-30%	(--)	90%	-
Linear Equipment Corridor	Note 1	75	50%	68	20%-30%	(--)	90%	-
Alcove (open)	100%	75	50%	68	20%-30%	(--)	90%	-
Tissue Culture	100%	75	50%	68	20%-30%	(+)	90%	Note 4
Procedure Room	100%	72	50%	68	20%-30%	(--)	90%	-
Vivarium/Animal Holding Room	100%	72	50%	68	30%-40%	(--)	90%	-
Glasswash	100%	78	60%	68	20%-30%	(---)	90%	-
Glasswash Equipment Space	100%	85	70%	68	20%-30%	(---)	90%	-
Environmental Room	Note 1 (If Req'd)	-	-	-	-	None	-	Note 2
Miscellaneous Spaces								
Mech. / Elec. Rooms	100%	95	None	68	None	None	30%	-
Tel/Data Rooms/BMS Control Room	-	75	50%	68	20%-30%	None	90%	Note 5
Elevator Machine Rooms	-	85	85%	60	No Control	None	30%	Note 5
General Storage	-	75	50%	68	20%-30%	None	90%	-
Hazardous Storage	100% Exhaust	75	50%	68	20%-30%	(-)	90%	-
Toilet / Locker Rooms	100% Exhaust	75	60%	68	20%-30%	(-)	90%	-
Loading Dock/Garage	100% Exhaust	85	70%	60	No Control	None	90%	Note 3
Copy Rooms	100% Exhaust	75	50%	68	20%-30%	(-)	90%	-
Housekeeping Closets	100% Exhaust	78	60%	68	20%-30%	(-)	90%	-
Server Room		75	50%	68	30%	(+)	90%	Note 5



Note 1: Minimum ventilation rate will be sized based on ASHRAE 62.1 Requirements. Each zone VAV system shall be capable of a reduced airflow setback mode initiated by the room occupancy sensor (provided by electrical division).

Note 2: Environmental room temperature control will be by Division 13.

Note 3: Enclosed loading dock receiving area will have CO monitoring and purge exhaust mode.

Note 4: Space pressurization will be positive relative to adjacent labs unless otherwise approved and coordinated with the Project Manager and tenants of the space. 150 cfm shall be the typical offset for a 36" wide door.

Note 5: Equipment cooling load served by dedicated chilled water or DX AC unit designed specifically for critical 24-7 cooling (similar to Liebert) (Chilled water coil preferred).

Note 6: Space temperature setpoint and relative pressurization will be adjustable via the building control system.

Note 7: Rooms with occupancy density greater than 25 people per 1000 square feet shall be provided with a CO2 sensor that will initiate a demand controlled ventilation response by the associated VAV box or air valve.

8. Internal Load Design Criteria: The following are only estimates and in all cases the actual equipment and lighting cooling load should be calculated.

Space Type	People Load Note 1	Lighting Load	Equipment Load	Remarks
Public Spaces and Office Areas				
Common Areas / Lobbies	250 gsf/person	1-2 W/gsf	0-1 W/gsf	-
Lobby	250 gsf/person	1-2 W/gsf	0-1 W/gsf	-
Auditorium	25 gsf/person	1-2 W/gsf	1-2 W/gsf	-
Offices	100 gsf/person	1-2 W/gsf	1-2 W/gsf	-
Conference Rooms	25 gsf/person	1-2 W/gsf	2-4 W/gsf	-
Class Rooms	25 gsf/person	1-2 W/gsf	0-1 W/gsf	-
Laboratory Spaces				
Open Lab	100 gsf/person	1-2 W/gsf	7.5 W/gsf	-
Enclosed Equipment Room	100 gsf/person	1-2 W/gsf	10-20 W/gsf	-
Linear Equipment Corr	200 gsf/person	1-2 W/gsf	10-20 W/gsf	-
Entry Alcove	100 gsf/person	1-2 W/gsf	5-10 W/gsf	-
Tissue Culture Alcove	100 gsf/person	1-2 W/gsf	5-10 W/gsf	-
Procedure Room	100 gsf/person	1-2 W/gsf	5-10 W/gsf	-
Glasswash	200 gsf/person	1-2 W/gsf	Note 2	-



Glasswash Equipment Space	-	1-2 W/gsf	Note 2	-
Darkroom	100 gsf/person	1-2 W/gsf	2-6 W/gsf	-
Environmental Room	-	-	-	-
Vivarium Spaces				
Holding Rooms	100 gsf/person	1-2 W/gsf	Note 2	Note 4
Procedure Rooms	100 gsf/person	1-2 W/gsf	Note 2	Note 4
Testing Rooms	100 gsf/person	1-2 W/gsf	Note 2	Note 4
Miscellaneous Spaces				
Mech. / Elec. Rooms	-	-	-	Note 3
Tel/Data Rooms	-	1-2 W/gsf	Note 2	-
Elevator Machine Rooms	-	1-2 W/gsf	Note 2	-
General Storage	200 gsf/person	1-2 W/gsf	0-2 W/gsf	-
Hazardous Storage	200 gsf/person	1-2 W/gsf	0-2 W/gsf	-
Toilet / Locker Rooms	-	-	-	Note 4
Housekeeping Closets	-	-	-	Note 4
Loading Dock Receiving	-	-	-	Note 4
Server Room	200 gsf/Wgsft	1-2 W/gsf	Note 2	

Note 1: People loads will be based on actual count of people.

Note 2: Equipment loads will be based on actual equipment heat gains as published by manufacturer where available.

Note 3: Space loads based on estimated equipment heat gain.

Note 4: Exhaust and cooling requirements will dictate air flow quantity (minimal cooling load). Design shall be based on infrastructure sized for a minimum of ten (10) air changes per hour or as required for space cooling.

9. Heating Source – MATEP

- a. The majority of buildings on HMS campus are connected to the existing MATEP steam distribution system located at the basement level and through tunnels that connect each building. The initial distribution pressure shall be 125 psig, but shall be reduced via a pressure reducing station for medium pressure steam (MPS) and low pressure steam (LPS).
 - i. MPS reduction shall be via a single stage, 125-50 psig, 1/3-2/3 pressure reducing station and will be distributed to process equipment such as cagewashers, autoclaves, glasswashers, clean steam generators and domestic hot water heaters.
 - ii. Steam pressure reduction for LPS use will occur via a single stage 50-15 psig, 1/3-2/3 pressure reducing station and will be distributed to HVAC equipment such as hot water heat exchangers, AHU preheat coils and humidifiers.



- iii. All steam condensate generated by the medium pressure steam system will be flashed, with flash steam recovered prior to returning to the condensate system.
 - iv. Condensate will be collected in a central receiver and discharged back to the MATEP condensate return system, via a duplex condensate receiver/pump set. Condensate pumps sets will be required at other locations within the building for sterilizers, heat exchangers and steam line trapping condensate. Main pumpset pressure shall be designed based on MATEP requirements.
 - v. The steam system shall include a flow metering station prior to PRV stations, Condensate flow meters are not required.
 - vi. Each building shall have a conductivity for monitoring building condensate that is pumped back to the central plant.
- b. Building heating hot water shall be generated in steam-to-hot water heat exchangers. Three (3) hot water loops will be installed with associated heat exchangers, pumps and flow/BTU meters, as follows:
- i. System No. 2: Building Reheat Water
 - ii. System No. 3: Building Radiation Water
 - iii. System No. 1: Animal Area Reheat Water (where applicable)

10. Heating and Cooling Energy Recovery (Required by Code)

- a. Energy Recovery for air handling unit systems shall be designed in accordance with the latest adopted version of the state energy code (IECC and ASHRAE 90.1).
- b. Multiple options for energy recovery shall be evaluated for each large scale project. The HMS project manager must approve of the design teams proposal for energy recovery prior to construction documents phase.
- c. Air handling systems with clean, non-hazardous exhaust airstreams shall utilize an enthalpy recovery wheel wherever possible.
- d. Air handling systems with dirty or hazardous exhaust shall utilize standard glycol heat recovery coils within the exhaust air handing units and the supply air handling units to recover sensible heat before being exhausted to outdoors. The system fluid shall be 40% propylene glycol. During winter operation, the supply unit coil shall preheat the intake air. During summer operation, the supply coil is available to pre-cool the intake air.
 - i. Heat pipes shall be an acceptable alternative to the glycol run-around loops for consideration in sensible only heat recovery applications.

11. Cooling Source – MATEP



- a. The majority of buildings on HMS campus are connected to the existing MATEP chilled water distribution system. (NRB, Warren Alpert and 641 Huntington Buildings have dedicated cooling plants).
- b. The cooling medium for this project shall be provided by new chilled water mains from the Longwood Medical Area central plant (AES).
- c. A chilled water flow meter will record the chilled water usage and report to the building automation system.
- d. A secondary chilled water pump and piping system will distribute chilled water to primary cooling equipment such as air handling units. The chilled water system will be designed with a minimum 15°F temperature difference.
 - i. Chilled water supply temperature = 42 degrees
- e. A deny valve piping arrangement will ensure the required building temperature difference of 15 degrees F is maintained.
- f. Chilled water pumps shall be variable flow/constant temperature difference to the building via a supply and return piping system. Pumps will be equipped with variable speed drives that will operate to maintain constant differential pressure across the system.
- g. New buildings on campus shall receive a plate and frame heat exchanger installed in a manner that will decouple the building from the campus/MATEP loop. Heat exchanger will be located in the basement with an automated control valve arrangement that shall allow for cooling to be supplied either to the building from campus, or from the building to campus should the building have its own chilled water source.

12. Process Cooling

- i. For Lab buildings that require a process cooling source, a separate process chilled water or condenser water loop shall be distributed throughout the to serve environmental room condensers, process cooling loads, computer room type units, water cooled compressors, etc.
- ii. Two (2) end suction pumps shall pump the water through a filter and a piping system shall distributed water to each floor via vertical risers.
 - 1. If chilled water is to be used, it shall be via a plate and frame heat exchanger coupled with the MATEP cooling loop.
 - a. Note that the process chilled water temperature could be set low enough to support the use of chilled beams throughout the building (approx. 58 degrees F).



- b. Alternatively, and only if the building has a local closed loop chilled water supply, blending of chilled water return with the supply could be used to serve a medium temperature chilled water loop to support chilled beams.
- iii. If condenser water is to be used as a source for heat rejection of equipment, it shall be generated via a ducted closed-loop cooling tower. The condenser water supply temperature shall be 85 degrees maximum, or lower as outdoor conditions allow. The Warren Alpert Building and LHRRB building each have similar systems.

13. New Air Handling Units.

- a. Units shall be custom fabricated by manufacturer experienced in providing full custom air handling units with 4" foam or fiberglass panels shall be provided for capacities greater than 5,000 cfm.
- b. Floors shall
- c. Smaller units shall be standard modular type units with 2" fiberglass wall construction unless otherwise determined by the HMS project manager and the design team.
- d. Supply and exhaust AHUs shall be sized for 100% of the connected load, sum of the peaks.
- e. Supply Units shall include the following components as standard:
 - i. Outside air and return air (where applicable) inlet Dampers and air flow stations,
 - ii. Return air type units shall have an air blender downstream of mixing section.
 - iii. Inlet sound attenuator,
 - iv. MERV 8 pre-filter bank and MERV 13 after filter banks (or per latest LEED Standards),
 - v. Energy Recovery Section (where cost effective and required by code),
 - vi. Steam or hot water Pre-heat coil (steam is preferred where available)
 - vii. Chilled water coil,
 - viii. Steam Humidifier,
 - ix. Supply fan array consisting of multiple plenum fans



- x. Variable speed drive (or drives depending on number of fans and critical nature of the affected zones),
 - xi. Supply Airflow Station,
 - xii. Discharge sound attenuator.
 - xiii. Final HEPA Filters (only required for vivarium or other critical environments),
 - xiv. Discharge plenum and smoke/isolation dampers
 - xv. Additional filtration as required.
- f. Access to all components requiring maintenance shall be accounted for in the layout of each unit.
 - g. Outside air Dampers shall be of aluminum or stainless steel construction.
 - h. Refer to section 237323 of these Standards for further requirements and acceptable manufacturers.

14. Chillers:

- a. Existing buildings shall continue to be served by the campus/MATEP chilled water loop.
- b. New buildings shall include a connection to the MATEP system, but shall also be provided with a local chilled water plant. The type and quantity of chillers will depend on capacity and the need for redundancy.
- c. At a minimum all plant equipment must exceed code required efficiencies. A life cycle cost analysis of all options must be performed and reviewed with HMS to guide plant decisions.
- d. New Chiller plants shall have the ability to backfeed the campus water distribution system.
- e. Acceptable chiller manufacturers subject to compliance with the specification:
 - i. Trane
 - ii. York
 - iii. Carrier
 - iv. Multistack

23 0510 – HVAC Commissioning

1. HVAC Commissioning



- a. The Design Team shall provide fully integrated design documents to ensure all required Contractors are fully responsible for supporting the 3rd Party Commissioning activities for the proposed systems to be commissioned. All required labor hours and materials shall be included for, at a minimum but not limited to, meetings, supporting documentation, field testing activities, ancillary testing equipment, off-season testing, data storage, support for 10 month warranty verification (if required), etc.
- b. The Design Team shall work with the project Commissioning Agent to incorporate all of their testing requirements into the contract specifications.

23 0514 – Variable Frequency Drives

1. Provide a complete variable frequency drive (VFD) in a single enclosure for all fans and pumps 2 hp or greater serving variable loads.
 - a. ECM motors will be acceptable for motors less than 2 HP.
 - b. Integral pump / VFD will be acceptable for motors less than 2 HP (similar to Grundfoss Magna3).
2. VFD's associated with air handling unit fan array shall be arranged in one of two options depending on unit capacity, total peak HP, and any required redundancy based on the critical level of the building.
 - a. At the least, two VFDs for each fan array shall be provided for redundancy.
 - b. One VFD per fan may be required for certain applications (such as Fanwall technology)
 - c. For smaller motor sizes, ECM motors may be an alternative.
3. for all pu. Acceptable manufacturers contingent on compliance with specifications are:
 - a. 30 HP and Larger (18-Pulse or Greater Units Only)
 - i. Yasakawa – Preferred Vendor
 - ii. Square D
 - iii. General Electric
 - iv. Cutler Hammer
 - v. Emerson
 - vi. Danfoss
 - b. 25 HP and Less (**6 Pulse or Greater**)
 - i. Yasakawa – Preferred Vendor
 - ii. Square D
 - iii. General Electric
 - iv. Cutler Hammer



- iv. Emerson
 - v. Danfoss
- c. The VFD manufacturer shall supply with submittal information, harmonic calculations made in accordance with IEEE 519-1992 Standards showing the specified THVD, line notching and the specified THCD limits are met. Calculations shall assume worst case system conditions. System 1-line, 480V transformer data, standby generator data, and primary fault current data are required to make these calculations and shall be provided in the system short circuit study.
- i. Total harmonic voltage distortion must be less than 3%
 - ii. Total harmonic current distortion must be less than 5% and harmonic table requirements $ISC / IL < 20$
 - iii. A detailed description of the tests, procedures and supporting calculations required to substantiate the installed systems compliance with the specified THD limits.
- d. Where 18 pulse drives will not fit in the available space or must be installed outdoors, an alternative to provide 6-pulse drives with a harmonic filter (similar to Matrix MTE) may be acceptable pending review by HMS project manager and facilities department. A complete harmonic analysis will be required per item c above.
- e. Each drive shall be mounted with its accessories in a single cabinet.
- f. Installation and start-up services for the equipment shall be covered by this specification.
- i. A direct BAS connection for relay of data via BACNET IP or Siemens FLN protocol is required for all VFDs. Analog signals are not acceptable.
- g. Input control signal to all VFDs shall be compatible with the automatic controls and/or building automation control system in the building.
4. All Drives
- a. VFDs located indoors shall be housed in a signal NEMA 1 metal enclosure (including 18-pulse transformer, filters, line reactor, and other required accessories).
 - b. Drives located outside shall be provided with a single NEMA 3R enclosure and an independent heating and cooling system to maintain manufacturer's ambient operating conditions.
5. For VFDs greater than 50 HP, the Contractor shall provide independent harmonic testing by an independent testing company. Provide readings with printouts of the harmonic current at each harmonic as well as the total voltage distortion. The following readings shall be provided:



- a. At each point of common coupling:
 - i. With all drives running with load
 - ii. With all drives off
- b. At the power connection to each drive:
 - i. With the drive running loaded
 - ii. With drive off

23 0516 – Pipe Expansion

1. Furnish and install all necessary offsets, joints, expansion loops, compensators, anchors and guides so that no stress is placed on the piping systems or equipment due to thermal expansion.
2. Make proper provision for expansion and contraction in all parts of piping systems wherever possible by means of pipe bends, pipe offsets, swing connections or changes in direction of piping. Where piping network cannot be employed to absorb expansion and contraction in the piping systems, provide expansion joint compensators.
3. Expansion compensator elements shall be selected by the engineer and/or manufacturer to withstand system pressure and temperature conditions and to absorb thermal expansion of the piping. Use of expansion compensators in non-accessible locations shall not be permitted.
4. The Engineers specifications shall require that the Contractor retain a registered Professional Engineer licensed to practice in the project state to review all loads imposed on the building structure and piping system to assure that no points are overstressed.
5. The maximum allowable stress shall be 15,000 psi for cold water, hot water, condensate, and steam and the maximum allowable stress shall be 2500 psi for generator exhaust piping if pipe material is low carbon steel A53 B or A106 B (Marks' Standard Handbook for Mechanical Engineers, Tenth Edition).
6. The Contractor shall submit shop drawings with calculations (with P.E. stamp) detailing the proposed anchor locations for review.
7. All anchor details and forces shall be submitted to the project structural engineer for review prior to any installation.
8. Make proper provision for expansion and contraction in all parts of piping systems:
 - a. Steam and condensate (all pressures including vents)
 - b. Hot water
 - c. All underground piping
 - d. Emergency Generator exhaust.
 - e. Relief vents



9. Wherever possible, provide expansion and contraction by means of pipe bends, pipe offsets, swing connections or changes in direction of piping.
10. Where piping network cannot be employed to absorb expansion and contraction in the piping systems, provide expansion joint compensators. Securely anchor all piping utilizing expansion loops and joints to the building structure with steel angles, properly braced and welded to the pipe.

23 0519.10 – Meters

- 1.
2. Acceptable manufacturers subject to compliance with the specifications.
 - a. GE (preferred vendor)
 - b. Controlotron
 - c. Onicon Preso
 - d. Barco
 - e. Foxboro
 - f. Veris
3. Sensing system components
 - a. Provide self-averaging annular sensor flow metering stations
 - i. At each pump
 - ii. At each central utility service entrance (MATEP Connections)
 - iii. Where shown on drawings
 - b. Flow metering systems shall include annular sensors with self-averaging interpolating tube design at each flow station and a portable meter set supplied by one manufacturer.
 - c. Each annular measuring station shall be complete with safety shutoff valves, quick coupling connections, and a tag showing designed flow rates, meter readings for designed flow rates, metered fluid, line size and tag, and station or location number.
 - d. Annular measuring sensor shall be made of 304 stainless steel.
 - e. Stations shall be either nipple suction or weld insert type, rated to 300 psi at 400°F. Annular measuring stations shall be rotatable sensing elements so that all pressure sensing ports can be pointed downstream when station is not in use.
 - f. Permanent pressure loss to the system shall not exceed 5" of water column (0.42 foot) of head on sizes over 1 1/2". Accuracy of the flow measuring elements shall be $\pm 2.3\%$, as verified by independent laboratory reports.



- g. All annular averaging flow elements shall have isolation or wet tap feature, 3 or 5 way manifold, and an indicating flow transmitter.
- 4. All Meters shall be integrated to the BAS either by BACNET IP, Modbus TCP, or direct BAS connection.
- 5. In-line type meters shall be used where the manufacturers required upstream and downstream piping distance for insertion meters cannot be met. In-line meters shall be installed with a bypass for servicing.
- 6. Pumps that are provided with integral VFD shall also include on-board metering.
- 7. Hydronic Flow Meter
 - a. Ultrasonic flow meters are preferred. Meters on MATEP water shall have no direct contact with the water.
 - b. Turbine meters (insertion or inline) may be used on process water closed loops that are local to the building.
- 8. Hydronic BTU Meter
 - a. Provide a BTU measurement system on all building chilled water, hot water and process water systems similar to Onicon System-10 BTU Meter.
 - b. The BTU meter electronics shall be housed in a steel 8"x10"x4" NEMA-13 enclosure and shall include a front panel mounted two-line LCD display for indication of BTU total, BTU rate, flow rate, and supply / return temperatures.
 - c. An internal 120 VAC or 24 VAC power supply shall be included to provide power to the BTU meter electronics and the turbine flow meter.
 - d. The BTU meter shall be compatible with building and campus communication networks and shall provide the following information via the main control bus:
 - i. Total thermal energy transfer
 - ii. Thermal energy rate
 - iii. Supply temperature
 - iv. Return temperature
 - v. Liquid flow rate
 - vi. Liquid flow total.
 - e. Temperature sensors shall be PT100 RDT type located in wells with 4-20 ma transmitters.
- 9. Steam Flow Meters – Ultrasonic preferred



- a. The flow meter shall be sized by the manufacturer for each specific application and installed according to manufacturer’s recommendations. Measurement shall be within 2% accuracy or better across the full range of flow.
- b. Install meter in accordance with manufacturer’s recommended straight pipe run requirements (including a flow straightener, if required) to ensure the accuracy of 2%. Provide lateral and horizontal supports as required to minimize vibration at the meter location.
- c. For saturated steam applications, the flow meter shall calculate mass flow corrected for density with real time calculations based on temperature measured by an integral 1000 ohm platinum RTD (similar to Onicon model F-4600 or 4200).
- d. Temperature sensors shall be PT100 RDT type located in wells with 4-20 ma transmitters.

23 0523 – HVAC Valves and Strainers

1. Provide isolation valves at all drains, piping mains and branches at all piping systems, equipment, risers and before and after all control valves.
2. Automatic Valve actuators shall be Belimo as standard (no plastic internal parts) for locations with limited or restricted access. Alternate manufacturers will be acceptable for other areas provided their warrantee includes a standard 5 year warranty.
3. Strainers on main building level water systems shall include a duplex basket strainer for redundancy and ease of service.
4. Valve Chart

Service	Minimum Class and Material			Joints	
	2" and Less	2½" to 12"	14" & Up	2" and Less	2½" & Up
Chilled water supply and return	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged or Grooved*
Secondary chilled water system	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged or Grooved*
Condenser water supply and return	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged or Grooved*



Service	Minimum Class and Material			Joints	
	2" and Less	2½" to 12"	14" & Up	2" and Less	2½" & Up
Boiler blowdown and blowoff	ANSI Class 300 Cast Steel	ANSI Class 300 Cast Steel	ANSI Class 300 Cast Steel	Threaded	Flanged
Hot water supply and return	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged or Grooved
Secondary hot water system	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged or Grooved
Low pressure steam (0 to 15 psig)	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged
Medium pressure steam (16 psig to 99 psig)	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged
High pressure steam (225 psi max.) (100 psig to 225 psig)	ANSI Class 300 Cast Steel	ANSI Class 300 Cast Steel	ANSI Class 300 Cast Steel	Threaded	Flanged
High pressure condensate return	MSS Class 250 Cast Iron	ANSI Class 300 Cast Steel	ANSI Class 300 Cast Steel	Threaded	Flanged
Low pressure condensate return	MSS Class 150 314 Stainless Steel	MSS Class 150 314 Stainless Steel	ANSI Class 150 Cast Steel	Threaded	Flanged
Medium pressure condensate return	MSS Class 150 314 Stainless Steel	MSS Class 150 314 Stainless Steel	ANSI Class 150 Cast Steel	Threaded	Flanged
Pumped condensate	MSS Class 150 314 Stainless Steel	MSS Class 150 314 Stainless Steel	ANSI Class 150 Cast Steel	Threaded	Flanged
Makeup and fill	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged or Grooved*
Miscellaneous drains 2½" and up		Match system			Flanged or Grooved*
Miscellaneous drains to 2"	Match system			Threaded	



Service	Minimum Class and Material			Joints	
	2" and Less	2½" to 12"	14" & Up	2" and Less	2½" & Up
Refrigerant system	MSS Class 150 Bronze	MSS Class 150 Steel	N/A	Silver Brazed	Flanged
Fuel oil	MSS Class 300 Bronze UL Listed	ANSI Class 150 Cast Steel UL Listed	ANSI Class 150 Cast Steel UL Listed	Threaded	Butt Weld
Fuel oil supply and return (boiler room)	ANSI Class 150 Cast Steel UL Listed	ANSI Class 150 Cast Steel UL Listed	ANSI Class 150 Cast Steel UL Listed	Socket Weld	Butt Weld
Fuel oil supply and return below grade	ANSI Class 150 Cast Steel UL Listed	ANSI Class 150 Cast Steel UL Listed	ANSI Class 150 Cast Steel UL Listed	Socket Weld	Butt Weld
Other piping	MSS Class 150 Bronze	MSS Class 150 Ductile iron or steel	ANSI Class 150 Cast Steel	Threaded	Flanged or Grooved*

* Grooved piping systems of standard wall shall be roll grooved or cut grooved according to Victaulic groove specification standards. On piping heavier than standard wall, cut grooving required per Victaulic cut groove specification standards. All grooved valves shall be a minimum class of 300.

23 0529 – Hangers and Supports

1. All system components shall be installed in accordance with local codes including seismic isolation as required.
2. All piping shall be hung to true alignment, using appropriate and substantial hanger arrangements. Wire and strap hangers will not be permitted. Hangers shall be located so that piping and hangers will be clear of other piping, hangers, conduits, lighting and other obstructions.
3. All pipes shall be hung free of dependence on pipe sleeves for support.
4. Install flexible connectors on the equipment side of the shutoff valves, horizontal and parallel to equipment shafts whenever possible.
5. All auxiliary steel required for pipe, duct and equipment supports shall be furnished and installed by the Mechanical Contractor



6. Furnish and install all necessary vibration isolation materials to eliminate excessive noise and vibration from all building mechanical systems
7. Provide concrete inertia base at all floor mounted pump sets.
8. Curb mounted rooftop equipment shall be mounted on structural spring isolation curbs that bear directly on the roof support structure, and are flashed and waterproofed into the roof's membrane waterproofing system.
9. Rooftop fans, condensing units, air handlers, etc. shall be mounted on continuous support piers that combines equipment support and isolation into (1) assembly. Support Rails shall incorporate spring or neoprene isolators which are adjustable, removable and interchangeable after equipment has been installed. Wooden sleepers that are not permanently affixed to the roof will not be accepted as they do not meet code.
10. Isolation systems must be installed in strict accordance with the manufacturer's written instructions and submittal data. Vibration isolators shall not cause any change of position of equipment resulting in stress on equipment connections
11. Avoid contact between dissimilar metals.
12. Provide double nuts on all threaded hangers.

23 0593 – Testing, Adjusting and Balancing

1. Furnish and install all hangers, supports and assemblies for all parts of the mechanical systems. This shall include all piping, ducts and equipment specified in this Division and as shown on the drawings
2. Renovation projects will require a pre-construction verification balancing report to identify any preexisting deficiencies of existing systems being utilized, The drawings and specifications shall clearly indicate this requirement. Report shall include local hood readings, traverse of local and floor main ducts as required, and pertinent fan system data.
3. Design cannot be considered complete without approved final balance report.
4. System balancing shall include:
 - a. Air System Balance
 - b. Hydronic System Balance
 - c. Control Systems Verification
 - d. Duct leakage testing
 - e. System Performance Verification
 - f. Opposite Season Test
 - g. Pre-Construction Verification survey report (for renovation projects)



23 0713 – Duct Insulation

1. Duct insulation thicknesses shall meet or exceed Code required thicknesses and R-Values.
2. Ductwork located in mechanical rooms or where exposed to view shall be rigid board with white finish.
3. Duct service type and flow direction shall be labeled every 15 feet at a minimum.
4. Where connecting to existing ducts, replace an additional 5 ft of insulation on either side of connection.
5. Where ductwork passes thru exterior building walls, the exterior portion shall use double the thicknesses scheduled up to 24 inches beyond the point where ducts (supply and return) enter the building.
6. Furnish and install all duct insulation, vapor barriers, jackets, finishes, adhesives, cements and accessories to make a complete and insulated system of all ductwork, fittings, joints, offsets and accessories.
7. All insulation system materials shall conform to the maximum flame spread/smoke developed ratings specified herein.
8. All kitchen hood exhaust ductwork and accessories shall be insulated with a rated fireproof insulation system with zero clearance allowed. The system shall extend continuously from the hood connections to the fan intake connection.
9. Duct insulation exposed to weather: Insulation Contractor shall cover all ducts exposed to weather with insulation in accordance with the insulation specification and Table 4.1 below but in no case shall this be less than 3” thick fiber glass rigid board insulation with vapor barrier for ductwork. When insulation application is completed, the entire installation shall be covered with EPDM roofing material or 3M VentureClad Model 1579GCW-WH. All joints shall overlap a minimum of 6 inches.
10. Insulation for the various duct systems and associated equipment shall be composed of materials which are non-combustible and/or provide a fire resistive system of insulation which complies with the applicable Code having jurisdiction. Generally, it is required that fire hazard ratings shall not exceed the following, except as noted:
 - a. Flame Spread Rating: 25 (No Exceptions)
 - b. Smoke Developed Rating: 50
11. All fire hazard ratings shall be as determined by NFPA 255 "Method of Test of Surface Burning Characteristics of Building Materials", ASTM E84 or UL 723.



12. Installation of all insulation work shall be executed by a qualified Insulation Contractor who is thoroughly experienced in this particular type of work at Harvard Medical School and who has adequate facilities and equipment for installation of all insulation work herein specified and who is familiar with the requirements of the Code enforcing Authorities as to fire hazard rating.
13. Ductwork Insulation Schedule

23 0719 – HVAC Piping Insulation

1. Pipe insulation thicknesses shall meet or exceed Code required thicknesses and R-Values.
2. Pipes 2-1/2" or greater located in mechanical rooms and high traffic areas shall include an additional PVC service jacket in accordance with HMS color code standard. Pipes 2" or less can be painted.
3. Pipe service type and flow direction shall be labeled every 15 feet at a minimum and at each side of wall penetrations. Insulation shall be continuous thru wall.,
4. Where connecting to existing ducts or piping, replace an additional 5 ft of insulation on either side of connection.
5. Provide removable blankets for hot service valves 2 1/2" or greater. Blankets shall not be wired together, provide Velcro, strings or other system that can be refastened.
6. Provide vapor barrier on all cold water and rainwater piping.
7. Equipment drains and floor drains from cooling coils as well as drinking fountain waste shall be insulated 6 feet downstream from connection point
8. Underground (direct buried piping):
 - a. The underground piping system for steam, condensate, chilled water, fuel oil and all components shall be of the prefabricated and pre-engineered types specifically designed for direct buried application. Piping shall be installed in strict accordance with the manufacturer's recommendations.
 - b. Acceptable manufacturers shall include Perma Pipe and Thermacore Process Inc.
 - c. Provide stress calculations and forces at all anchors, guides and supports based on actual installed locations.
 - d. All underground prefabricated piping shall be accountable to ANSI 31.1 requirements
 - e. Steam and condensate service: Provide a product similar to Perma Pipe Multi Therm 500.



- f. Chilled Water Service piping installed underground: Provide a product similar to PPR-CT plastic piping. No insulation or thrust blocks are required.
- 9. Furnish and install all piping insulation, vapor barriers, jackets, finishes, adhesives, cements and accessories to make a complete insulated system for all piping, valves, fittings, joints, offsets and flanges specified herein.
- 10. All insulation system materials shall conform to the maximum flame spread/smoke developed ratings specified herein.
- 11. Hard insulation material or insulation shields shall be provided at all hangers.
- 12. Insulate the following:
 - a. All scheduled piping, all valves, fittings, elbows, flanges and accessories.
 - b. All piping exposed to weather including provision of additional weatherproof jacket.
 - c. All cold water make-up piping and valves. All drain and overflow piping receiving cold water. Piping to/from expansion/compression tanks.
 - d. All vents and blow-offs in mechanical rooms and elsewhere within reach of personnel.
 - e. Emergency generator piping and entire exhaust systems.
 - f. Piping jacket covers.
 - g. All heat traced piping.
- 13. Piping insulation for the various piping systems and associated equipment shall be composed of materials which are non-combustible and/or provide a fire resistive system of insulation which complies with the applicable Code having jurisdiction. Generally, it is required that fire hazard ratings shall not exceed the following, except as noted:
 - a. Flame Spread Rating 25 (No Exceptions)
 - b. Smoke Developed Rating: 50
- 14. Installation of all insulation work shall be executed by a qualified Insulation Contractor who is thoroughly experienced in this particular type of work at Harvard Medical School and who has adequate facilities and equipment for installation of all insulation work herein specified and who is familiar with the requirements of the Code enforcing Authorities as to fire hazard rating.
- 15. The finished installation shall present a neat and workmanlike appearance with all jackets smooth, with all vapor barriers sealed and intact.



16. All chilled water system piping, components and accessories are to be insulated in a manner so as to provide a complete, uninterrupted vapor barrier. This includes sealing ends of at all butt joints of insulation segments.

17. Ensure insulation is continuous through interior walls. Pack around pipes with fire proof self-supporting insulation material, fully sealed. Insulation on all cold surfaces where vapor barrier jackets are specified must be applied with a continuous, unbroken vapor seal. Hangers, supports, anchors, and other heat conductive parts that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation

18. All pipe elbows shall be insulated with short radial and mitered pieces of board or block insulation or removable pre-molded pieces of pipe insulation. Each piece shall be butted tightly against the adjoining piece and all joints, seams, voids and irregular surfaces shall be filled with insulating cement finished to a smooth, hard and uniform contour. Coat with MAS-1 mastic and reinforce with ADJ-2 additional jacket. In addition, place a fitted PVC cover (ADJ-4) over insulated elbow.

19. Additional Insulation Jacket

- a. ADJ-1: Approximately 6 ounce per square yard glass cloth jacket with thread count of 5 strands per square inch.
- b. ADJ-2: Approximately 2 ounce per square yard glass cloth jacket with a thread count of 10 strands by 10 strands per square inch. Jacket shall be used for covering pipe and pipe fittings.
- c. ADJ-3a: 0.016 inch thick aluminum jacket conforming to ASTM B-209 with a 1 mil factory applied polykraft moisture barrier. Longitudinal joints shall be placed at the side of the pipe facing downward at either the 4 o'clock or 8 o'clock position so as to shed water. Aluminum fitting covers, two piece elbows, tees, valve and flange covers, etc., with a 1 mil polykraft or acrylic vapor barrier.
- d. ADJ-4: 20 mil PVC jacket suitable for all types of paint. Similar to Manville Zeston 25/50.
- e. ADJ-5: shall be a Cell-Co plastic jacket with the following color coded pattern:
 - i. Steam (HP/LP): White
 - ii. Condensate (Pump/Gravity): White
 - iii. Hot Water: Orange
 - iv. Chilled Water: Blue
 - v. Condenser Water: Green
 - vi. Vent: Black
 - vii. City Water: Gray
 - viii. Fuel Oil: Yellow
 - ix. Boiler Services: White
 - x. Engine Exhaust & Breeching: Brown



- xi. Glycol Heat Recovery Water: Orange
- xii. Process Cooling Water: Green
- xiii. Other Yellow-green

- f. ADJ-6 A finish jacket of an Asbestos-free and woven as high temperature, heat-resistant fabric. Lagging Cloth having a treated weight of 24 oz./sq.yd. Material shall be suitable for a sustained operation at 1100°F. Calcium silicate piping for generator exhaust piping shall also be jacketed with corrugated aluminum.

23 2000 – HVAC Piping and Joints

1. Provide all piping, fittings, flanges, couplings, unions, bolting, gaskets, welding, threading and soldering for main piping network, branches and connections to equipment as shown on the drawings and as required to provide complete systems. All piping, fittings and accessories shall conform to the appropriate Service Pipe Schedule as specified hereinafter.
2. Elbows shall be long radius ANSI B16.9 unless otherwise specified
 - a. Provide drains at low points and vents at high points of all piping systems and between pumps and check valves.
 - b. Steam pipes shall be provided with drip legs and traps at all low points and as otherwise specified.
3. Steam service as specified herein shall include steam trap piping to and including shut-off valve on trap discharge and relief valve discharge
4. Piping alternates:
 - a. (Basis of Design) Heat Fused Piping: Contractor option to provide polypropylene (PPR-CT) piping for chilled water and cold water service. Acceptable manufacturers include: Aquatherm, Niron, or Peston.
 - i. Piping to be installed by certified installer and per manufacturer recommendations.
 - ii. Insert language from plumbing spec.
 - b. Alternate: Victaulic: Contractor's option to provide mechanical couplings and fittings in lieu of welded fittings and joints for water service not exceeding F in exposed areas and mechanical rooms or runs above ceiling tile or drop ceiling that provide access.
 - c. Alternate: Pro-Press: Contractor's option to provide ProPress fittings for chilled water, cold condenser water and hot water piping (service up to 200 degrees) fittings in accessible locations (not in shafts) for copper piping sized 2-1/2" and below as noted in pipe schedule.



5. Service Pipe Schedule

Service	Type	Grade	Wall		Joints (Minimum Sch. Shall match Wall)		Test Pressure
			to 10"	12" & Up	2" and Less	2½" & Up	
Chilled water supply and return (New Work)	PPR-CT	-	Sch.40	Standard 0.375"	Heat Fused	Butt Welded Note 3&5	225
Chilled water supply and return (renovation work less than 10 feet to existing pipe mains)	A106 or A53 Seamless or ERW	A or B	Sch.40	Standard 0.375"	Threaded Note 3	Butt Welded Note 3 & 5	225
Hot water supply and return	A106 or A53 Seamless or ERW	A or B	Sch.40	Standard 0.375"	Threaded Note 3	Butt Welded Note 3	225
Pumped condensate	A106 or A53 Seamless	A or B	Sch.80	Extra Strong 0.5"	Threaded	Butt Welded	225
Low pressure steam (0 to 15 psig)	A106 or A53 Seamless or ERW	A or B	Sch.40	Standard 0.375"	Threaded Malleable	Butt Welded	225
Medium pressure steam, supply, & RPV Safety relief vents thru roof (16 psig to 99 psig)	A106 or A53 Seamless or ERW	A or B	Sch.40	Standard 0.375" Note 4	Socked Welded	Butt Welded	225
High pressure steam (100 psig to 225 psig)	A106 or A53 Seamless	A or B	Sch.80	Extra Strong 0.5"	Socket Welded	Butt Welded	325
High pressure condensate return	A106 or A53 Seamless or ERW	A or B	Sch.80	Extra Strong 0.5"	Socket Welded	Butt Welded	225
Hot well steam condensate and pump discharge to 2½" & up	A106 or A53 Seamless or ERW	B	Sch.80	Extra Strong 0.5		Butt Welded	325
Hot well steam condensate and pump discharge to 2"	A106 or A53 Seamless or ERW	B	Sch.80	Extra Strong 0.5"	Threaded Malleable		325



Low pressure condensate return	A106 or A53 Seamless or ERW	A or B	Sch.80	Extra Strong 0.5"	Threaded Note 1	Butt Welded	225
Medium pressure condensate return	A106 or A53 Seamless or ERW	A or B	Sch.80	Extra Strong 0.5"	Threaded Note 1	Butt Welded	225
Make-up and fill (up to 150F on grooved)	Hard Drawn Copper	ASTM B88	Type L		95-5 Solder Note 3	Silver Brazed Note 3	225
Miscellaneous atmospheric vents (up to 150F on grooved)	A53	A or B	Sch.40	Standard 0.375"	Threaded Note 3	Butt Welded Note 3	225 (with air)
Miscellaneous drains 2½" & up (up to 150F on grooved)	A53	A or B	Sch.40	Standard 0.375"		Butt Welded or Grooved Note 2, 3	225
Miscellaneous drains to 2"	Hard Drawn Copper	ASTM B88	Type L		DWV 95-5 Solder Note 3		225
Emergency generator exhaust	A106 or A53 Seamless or ERW	B	Sch.40	Standard 0.375" Note 4	Butt Welded	Butt Welded	225 (with air)
Fuel oil supply and return	See Fuel System Specification Section						See Spec
Fuel oil supply and return below grade	See Fuel System Specification Section						See Spec
Contractor option Chilled water 2" or Less	A106 or A53 Seamless or ERW	A or B	Sch. 40	Standard 0.375"	Threaded Note 3	Butt Welded Note 3	225
Contractor option Chilled or Hot water 2" or Less	Hard Drawn Copper	ASTM B280	Type L	None	Silver Brazed Note 3		225
Other piping (up to 150F on grooved)	A106 or A53 Seamless or ERW	A or B	Sch.80	Extra Strong 0.5"	Threaded Malleable Note 3	Butt Welded Note 3	325

Note 1: In concealed inaccessible location provide socket welded.



Note 2: Outdoor portion of piping shall be painted with a high temperature rust inhibiting primer and two coats of high temperature enamel paint (color shall be black unless otherwise selected by the architect).

Note 3: ProPress: fittings will be acceptable as a contractor joint option for chilled water, cold condenser water and hot water pipe fittings in accessible locations (not in shafts) for copper piping sized 2" and below as noted in pipe schedule.

Victaulic: Contractor's option to provide mechanical couplings and fittings in lieu of welded fittings and joints for water service not exceeding 150°F in exposed areas and mechanical rooms or runs above ceiling tile or drop ceiling that provide access.

Note 4: Where piping extends above roof and is exposed to weather, it shall have an additional 20 gauge polished stainless steel external protective cladding.

Note 5: Polypropylene (PPR-CT) piping: Contractor option to provide polypropylene (PPR-CT) piping for chilled water and cold water service. Where PPR piping is installed outdoors, UV protection shall be provided.

6. All equipment and piping installed shall be tested and found tight. Insulated or otherwise concealed piping shall be tested before being closed in. All leaking joints shall be corrected, retested and found tight.
7. All piping systems shall be subjected to a hydrostatic test at the scheduled test pressure for a period of (4) hours without drop in pressure.
8. All oil piping shall be subject to a test with oil at 225 PSIG for a period of (4) hours without drop in pressure.
9. Tests of piping systems shall be conducted before connections to equipment are made and before piping is covered, buried or otherwise concealed.
10. Welded joints shall be subjected to a hammer test while under pressure.

23 2123 – HVAC Hydronic Pumps and Accessories

1. Furnish and install all pumps and accessories for all systems which are part of the building HVAC systems. This shall include all accessories specified in this Division and as shown on the drawings.
2. Provide base mounted, horizontal axial split-case, or vertical mounted split-case, double-suction, single-stage centrifugal pumps, or base mounted, single-stage end suction radial pumps, as shown on the drawings. Capacity, RPM, head and electrical motor characteristics shall be as scheduled on the drawings.
3. Pumps General:
 - a. Pumps up to 2 HP shall include an integral VFD and controller with outputs for BAS monitoring.



- i. Pump sized 3" and larger shall include monitoring of flow, inlet and outlet temperature, pressure and power thru the VFD and on-board controller.
 1. Meter accuracy shall be within 1% or as defined in the VFD specification section 230514.
 2. These meters are in addition to standard flow meters mounted to pipes.
 - ii. Input control signal shall be compatible with automatic controls and/or building automation control system.
 - iii. Provide a direct BAS connection for relay of pump/VFD data via Bacnet IP or Siemens FLN protocol is required for all VFDs. Analog signals are not acceptable.
 - iv. The pump mounted dP sensor shall not replace the system sensor. A dP sensor shall still be required at the furthest hydraulic point in the system for monitoring and speed control.
- b. Pumps greater than 2.5 Hp require external VFD including Current transducer to verify pump status.
 - c. Construction shall permit complete servicing without breaking pipe or motor connections.
 - d. Pumps to operate at 1750 rpm unless scheduled or specified otherwise.
 - e. Provide guards around shafts and couplings in accordance with OSHA and ANSI recommendations.
 - f. All parts shall be suitable for variable frequency drives; including but not limited to motor, pump, all pump components, coupling, and base.
 - g. Pumps shall be installed so as to ensure easy accessibility for service or removal and replacement of all components such as, but not limited to, impellers, motors, drive couplings, bearings, strainers, other pump appurtenances and isolators.
 - h. Set pump on concrete base, anchor, level and grout according to manufacturer's instructions. Provide vibration isolators under pump base.
 - i. Provide line sized shutoff valve and strainer on suction and line sized silent check valve and flow control balancing valve on discharge.
4. Decrease from line size, with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and over Expansion Tanks



- a. Provide expansion and compression tanks, air separator and other pump hydronic accessories for each closed loop water circulation system.
 - i. Ensure that tanks have capability/Fitting for testing and repressurization.
 - b. Tanks shall be the pressurized captive air bladder type.
 - c. Provide replaceable elastomeric bladder suitable for a maximum operating temperature of 240 deg F
 - d. Provide integral steel base ring for vertical mounting.
 - e. Tanks shall be constructed and certified to ASME Section VIII
 - i. Pressure rating 150 psig
 - ii. Temperature of 240°F
 - f. Provided with charging valve enclosure, remote air connector coupling, system connection and lifting rings.
 - g. Tanks shall be provided with factory applied rustproof coat of paint to the exterior of tanks.
5. Air Separators:
- a. Provide air/dirt separator with flanged inlet and outlet connections for each closed loop pumping system.
 - i. Provided with drain connection with valve.
 - ii. Shall be tangential type with bottom blow down.
 - iii. Full size removable strainer.
 - iv. Pressure drop shall be 1 foot of water and maximum velocity shall be 4 fps.
 - v. Provide temporary bypass around all air/dirt separators.
 - vi. Acceptable Manufacturers: Spirotherm or B&G.

23 2223 – Steam and Condensate Specialties

1. Furnish and install all steam and condensate specialties and equipment to make complete and operations systems.
2. All systems shall be installed in accordance with local code including vent piping and relief discharge termination points.
3. Pressure Reducing Valves
 - a. Acceptable manufactures subject to compliance with the specifications:



- i. Spence
 - b. Furnish and install, as shown and scheduled on the drawings, steam pressure reducing valves of the self-operated, external pilot type, single seated, normally closed, metal diaphragm actuated, similar to Spence Type ED.
 - c. Valves shall regulate an accurate delivery pressure within ± 1 lb. throughout the range of pressure and flow conditions scheduled, regardless of deviation of the inlet steam pressure. Valves shall function quietly and shut tight on deadend shutoff. Regulators shall respond quickly and accurately without pressure deviation when installed on a 2-stage reduction.
 - d. A 1/3 – 2/3 dual valve arrangement shall be used for each reducing stage sized for greater than 1000 pounds per hour, or when significant turndown or widely fluctuating loads are anticipated.
 - e. Bodies 2" and under shall have screwed ends, cast iron body, 250 lb. working pressure construction, size 2 1/2" and up shall have flanged ends. Seats and discs shall be guaranteed by the manufacturer against the wire drawing action of steam. Stems shall be stainless steel.
 - f. The pressure pilot shall be separate from the main valve and connected to it by unions. A strainer screen shall be built into the pilot inlet. Pilot shall be interchangeable with all sizes of main valves and connected to the main valve by unions. Bleedports and other orifice fittings shall be externally connected to facilitate troubleshooting and cleaning. Internal bleedports will not be permitted.
 - g. The maximum or end point capacity of the regulator shall not pass more than 20% in excess of the required capacity. (Safety valve to be sized to pass 100% of the maximum or end point capacity.)
 - h. Valves shall be sized so that the valve body inlet velocity does not exceed 8000 fpm and the valve body outlet velocity does not exceed 20,000 fpm or the combined inlet and outlet velocity does not exceed 28,000 fpm.
 - i. Provide inlet gate valve, steam strainer, outlet gate valve, bypass and safety.
 - j. Provide noise suppressors and muffling orifice plates downstream of each PRV valve as required to meet job conditions. Suppressors similar to Spence Model "B".
4. Safety Valves
- a. Acceptable manufactures subject to compliance with the specifications:
 - i. Kunkle
 - ii. Spence



- iii. Dresser Inc.
 - b. Safety valves shall be of size and setpoint as required by PRV manufacturer.
 - c. Valves shall be cast iron body, lead seal, asbestos free packing and gasket and brass shaft. All internal parts made of cold rolled steel shall be cadmium plated. Provide drain pipe and valve to nearest floor drain and flexible connectors at pipe discharge as shown on the drawings.
 - d. Poppet valves are not acceptable.
5. Steam Traps
- a. Acceptable manufactures subject to compliance with the specifications:
 - i. Armstrong (preferred)
 - ii. Sarco
 - iii. Velan
 - iv. Strong
 - b. Provide drip trap assemblies as follows:
 - i. Steam piping
 - 1. Maximum of 75 feet intervals.
 - 2. At rising points in piping
 - 3. At the bottom of all vertical pipes.
 - c. At all steam entrance points at building wall
 - d. Provide temp sensors on discharge side for 2" and larger traps with with BAS connection for alarm.
 - e. Provide steam traps at all low points of the low pressure, medium pressure and high pressure steam systems, at equipment and as shown on the drawings and required by job conditions. Steam traps used for equipment using low pressure steam (LPS) shall be the closed float and thermostatic type.
 - f. Traps used for medium (MPS) or high pressure steam (HPS) shall be Class 300 inverted bucket type for modulating loads. Inverted Buckets shall be utilized for steam line trapping and other constant loads. Main line warm up shall be timed so that traps may clear the condensate from the main without flooding or producing objectionable water heaters.
 - i. Disk type traps are not acceptable since central / MATEP steam may be dirty.
 - g. Add clarification for each type of steam service.



- h. General Trap Requirements:
 - i. Provide dirt pockets at all traps (min 12")
 - ii. Provide union on both sides.
 - iii. Provide inlet with strainer
 - iv. Provide discharge check valve.
 - v. Provide discharge shut off valve.
 - vi. Locate traps.
 - 1. So all traps can be accessed for replacement and maintenance.
 - 2. At steam equipment.
 - 3. Locate so as not to be subject to freezing.
- 6. Condensate Pump Sets (Electric)
 - a. Acceptable manufactures subject to compliance with the specifications:
 - i. Shipco
 - ii. Skidmore
 - iii. Domestic
 - iv. Webb (stainless steel)
 - b. Unit shall consist of a cast iron receiver, inlet strainer, (2) pumps (maximum 2'-0" NPSH each), float switches, electrical controls and accessories, as follows:
 - i. Receiver shall be manufactured of stainless steel when available at the designed capacity. The receiver shall be equipped with externally adjustable 2-pole float switch, water level gauge and eye bolts. Pressure gauges shall be provided in the field by the Contractor.
 - ii. A cast iron inlet strainer with vertical self-cleaning bronze screen and large dirt pocket and (1) dial thermometer with well shall be mounted on the receiver. The screen shall be easily removable for cleaning, requiring no additional floor space for servicing.
- 7. Flash Tanks
 - a. Acceptable manufactures subject to compliance with the specifications:
 - i. Modern welding.



- ii. Armstrong
- iii. Wessel

- b. Provide flash tanks as indicated on the drawings. Each tank shall be ASME rated. All seams shall be continuously welded.

- c. The minimum ASME rating shall be 125 PSIG unless scheduled greater.

- d. Provide trap arrangement, relief valve and vent (pipe to atmosphere) and connections to low pressure steam, as shown on the drawings.

23 2500 – Chemical Water Treatment

1. Furnish and install all equipment, controls, chemicals, labor and accessories to make a complete system for chemically treating the HVAC hydronic systems specified herein.

2. All chemicals shall be environmentally safe and compatible.

3. The Mechanical Contractor shall engage the services of a nationally recognized water treatment manufacturer with local representative of such manufacturer to provide a complete water treatment service, designed to minimize corrosion and scale formation in all water systems. This service shall include providing the equipment, controls, chemical feed pumps, shot feeders, all chemicals and consulting analysis service for the initial start-up of each system.

4. Service Period: Provide chemicals and service program for a period of one (1) year from start-up date of condensing equipment.
 - a. Chemical treatment representative shall visit the site once every month during the guarantee period. The representative shall check and adjust water treatment system operation during each visit, check efficiency of chemicals and chemical applications, and instruct and advise operating personnel.

 - b. The HVAC Contractor shall closely coordinate with the water treatment company to insure that each piping system is properly cleaned prior to placing in use and that no system is filled with water without proper water treatment chemicals being added.

5. Systems
 - a. Hot water and chilled water - Provide a 5 gallon capacity, bypass feeder with the wide mouth opening and quick disconnect cap for each hot water and chilled water system

 - b. Condenser water - Provide an automatic prefabricated analyzing control and chemical feed system consisting of continuous monitoring of system.
 - i. The Contractor shall provide ASTM corrosion coupon test racks in accordance with the chemical treatment service organization requirements



- c. Glycol Systems - Provide complete initial fill of 30% propylene glycol/70% water for all glycol systems. Propylene glycol solution shall be similar to Dowfrost as manufactured by Dow Chemical Co. or Union Carbide UCAR-17. Top off, test and adjust system solution after all piping systems have been tested and received. System shall include chemical injection pump and automatic glycol fill system.

23 3100 – Sheet Metal Work and Accessories

- 1. Furnish and install a complete system of air distribution, including accessories, to all areas indicated on the contract documents. Provide all ductwork, fittings and accessories to make a complete and operational system in all respects.
- 2. All ducts and fittings shall be manufactured by a sheet metal fabrication company whose primary business experience is the manufacture of commercial and industrial quality ducts and fittings. Sheet Metal Contractor shall have adequate experience of building ductwork of the types required for this project as well as successful experience with projects of similar scope. Bids from sheet metal shops which do not meet the specified requirements shall not be acceptable.
- 3. All duct systems specified to be installed under this Contract, shall conform to the drawings, specifications, Standards, details and recommendations of the latest edition of SMACNA "HVAC Duct Construction Standards - Metal and Flexible"; and "Round and Industrial Duct Construction Standards" (hereinafter referred to as Duct Manual).
- 4. The Sheet Metal Contractor shall install all duct mounted smoke detectors and provide proper cross trade layout coordination to allow for appropriate service/access requirements.
- 5. The Sheet Metal Contractor shall furnish and install all plenums with automatic or manual dampers attached to louvers.
- 6. In addition to sheet metal ductwork provided under this Contract furnish and/or install accessories and devices furnished by others, including but not limited to smoke detectors. Provide and install miscellaneous sheet metal work including safing, mixing baffles, and blank off panels at unused louver areas.
- 7. Control panel location shall be outside of rooms requiring critical level access (Vivarium, DNA Suite, Tissue Culture or as required by HMS).
- 8. Coils and valves shall not be located above large microscopes, mass specs and other critical lab equipment.

23 3363 – Air Flow Measuring Stations

- 1. Space pressure monitors



2. Airflow/Temperature Measurement Devices
3. Manufacturers
 - a. Setra (preferred mfg),
 - b. Ebtron
 - c. Or provide by fan manufacturer: Plenum fan pitot tube integral airflow stations are also acceptable in AHU's.

23 3390 – Fans and Accessories

1. Centrifugal
2. Mixed flow is preferred.
3. Plenum
4. Inline
5. Roof lab exh fans
6. AHUs – plenum fan array
7. Provide VFD's on all fans over 2.5hp
8. Fans less than 2.5HP shall be ECM type motor.
9. Provide fan capacity redundancy where possible:
 - a. Labs – 50%
 - b. Vivarium – N+1 (100%)

23 3600 – Air Terminal Boxes

1. Controls provider shall provide box mfg with control panels for factory installation when possible.
2. VAV boxes shall be provided with discharge air temperature sensor.
3. VAV boxes shall be lined with minimum of 1" thick thermal and acoustic insulation meeting "Hospital Grade". Closed cell foam may be used to meet this requirement.



4. Access doors shall be securely attached to the box upstream and downstream of the integral hot water heating coil.
5. Identify each terminal unit with clearly marked with: Box Identification number matching the drawings, Air flow, Maximum factory-set air flow, Minimum factory-set air flow, Coil type, and Direction of air flow.
6. The damper actuator shall be mounted on the exterior of the terminal for ease of service.
7. VAV boxes shall include sound attenuating section.
8. Refer also to BAS specifications and standards for control system requirements.

23 3620 – Laboratory Pressurization Control System

1. Siemens shall be the basis of design for all new laboratory controls systems The airflow control device shall be a venturi type valve with electric actuation. The airflow control device shall be pressure independent over its specified differential static pressure operating range.
2. For lab renovation projects where existing Phoenix control systems are in operation, consult HMS Project Manager to advise if the existing system should be reused or replaced. Factors such as system age, conditions, controls system compatibility, maintenance and cost of replacement shall all be considered.
3. A laboratory airflow control system shall be furnished and installed to control the airflow into and out of laboratory rooms. The exhaust volume of a laboratory fume hood shall be precisely controlled by an Adaptive Face Velocity controller to maintain a constant average face velocity into the fume hood at either a standard/in-use or standby level based on actual hood usage. The laboratory control unit shall vary the amount of air into the room to maintain temperature control, minimum ventilation, airflow balance, and laboratory pressurization in relation to adjacent spaces (positive or negative). All laboratory airflow control systems devices shall be by a single manufacturer and integrated to the building/campus BAS.
4. The laboratory airflow control system shall use volumetric offset control to maintain room pressurization and auxiliary fume hood make-up air tracking. The system shall respond and maintain room pressurization (negative or positive) within one second of a change in room/system conditions.
5. The laboratory airflow control system shall maintain specific airflow ($\pm 5\%$ of signal) with a minimum 15 to 1 turndown to insure accurate pressurization at low airflow and guarantee the maximum system diversity and energy efficiency.
6. Fume hood monitor shall include a numerical velocity display to indicate a relative measure of hood face velocity, visual indication for normal operation, visual and audible alarm for an unsafe alert and visual and audible alarm to indicate emergency exhaust operation.



7. Class A-The airflow control device for non-corrosive airstreams such as room/lab supply and general exhaust shall be constructed of 16 gauge aluminum. The device's shaft and shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal mounting link shall be made of aluminum. The pressure independent springs shall be spring-grade stainless steel. All shaft bearing surfaces shall be made of a Teflon, or polyester, or PPS (polyphenylene sulfide) composite.
8. Class B-The airflow control device for corrosive airstreams such as fume hoods and biosafety cabinets shall have baked-on corrosion resistant phenolic coating. The device's shaft shall be made of 316 stainless steel with a Teflon coating. The shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal mounting link shall be made of 316 or 303 stainless steel. The pressure independent springs shall be a spring grade stainless steel. The internal nuts, bolts and rivets shall be stainless steel. All shaft bearing surfaces shall be made of Teflon or PPS (polyphenylene sulfide) composite.
9. A night energy waste alert circuit employing a light level sensor shall be included in the monitor to sense the combination of a darkened laboratory room and a fume hood that has its sash left up.
10. The laboratory control system shall have the ability to change the minimum ventilation and/or temperature control set points, based on the occupied state, in order to reduce energy consumption when the space is not occupied. The occupancy state may be set by either the BMS, as a scheduled event, or through the use of a local occupancy sensor or switch.

23 4100 – Air Filters

1. MERV 8 prefilters and MERV 13 final filters (or as required by current codes) cartridge filters shall be standard at AHUs or per latest version of LEED.
2. Carbon filters are required wherever vehicle exhaust is possible at building air intakes.
3. Vivarium spaces require final HEPA filters.

23 5700 – Heat Exchangers

1. Shell and tube type Acceptable Manufactures contingent on compliance with the specification
 - a. Bell & Gossett
 - b. Armstrong
 - c. Amtrol
 - d. Patterson-Kelly



2. Shell and tube Heat exchangers shall be constructed with cast iron heads, steel shell baffles, and steel or cast iron removable tube sheets for heating hot water, copper tie rods, and steel nuts and bolts.
3. Plate and Frame type Acceptable manufacturers subject to compliance with the specifications:
 - a. Alfa-Laval
 - b. Bell & Gossett
 - c. Mueller
 - d. Patterson-Kelly.
4. Heat exchanger construction shall consist of an epoxy coated steel frame with steel plate carriers, steel compression bolts, gaskets, Type AISI 304 stainless steel replaceable plates, and an aluminum or galvanized steel protective plate pack shroud.
5. A minimum of 25% capacity shall be included in the frame length to allow for future expansion.
6. Heat exchanger shall be UL certified
7. Flow meters required on all hot water distribution systems.
8. Provide Inlet and outlet temperature sensors.
9. ASME U certification is required for all vessels.

23 7323 – Factory Built-Up Air Handling Units

1. Provide Epoxy floors on all new and retrofit AHUs similar to Aquis Solutions.
2. Supply air to Laboratory spaces shall be via 100% outside air systems without recirculation.
3. Supply air to Office, Classroom and other Non-Lab spaces shall be via recirculating air handling units.
4. General Unit Requirements:
 - a. Acceptable manufacturers subject to compliance with the specification:
 - i. Air Enterprises
 - ii. Buffalo Air Handling
 - iii. Environmental Air Systems (EAS)
 - iv. Haakon
 - v. Ventrol
 - vi. Trane Custom



5. A multiple fan array shall be provided at all laboratory air handling units greater than 5,000 cfm. Fan quantity shall be optimized based on performance and serviceability.
 - a. Each fan assembly shall be supplied with a complete flow measuring system, which indicates airflow in Cubic Feet per Minute.
 - b. A surface mounted airflow indicator, located on the unit exterior, shall provide a digital analog CFM readout, and/or a (4-20 ma) (0-10 volt) output control signal for use in the BAS as specified elsewhere.)
6. The unit housing shall have a minimum U value 0.062.
7. Exterior of casing shall be Painted galvanized steel (indoor and outdoor units), painted aluminum (outdoor units only), or unpainted stainless steel (unless noted hereinafter to also be painted).
8. Interior of unit casing shall be solid painted galvanized steel Solid Aluminum, or Solid Stainless Steel, dependent on the application.
9. Lab Exhaust AHU's shall have all aluminum or stainless steel interior construction.
10. The floor of each unit section shall be diamond safety plate. Floor shall be continuously welded to form a guaranteed waterproof surface. The entire floor system shall hold 2" of water throughout the unit footprint.
11. Coil support framing and drain pans shall be stainless steel. Filter frames shall be stainless steel.
12. Provide access doors of the same construction and thickness as the unit casing for all unit sections containing equipment requiring service.

23 8235 – Terminal Heat Transfer Units

1. Unit Heaters
 - a. All type heaters, as applicable, shall be hung with vibration spring isolators as hereinbefore specified.
 - b. The Contractor shall provide control valves and unit or remote mounted thermostats and wire to fan, to cycle fan "on/off."
 - c. The Contractor shall make provisions to "open/close" the steam or water control valves when heaters are "on/off", as indicated hereinafter.
 - d. Unit manufacturer shall provide starters and disconnect switches.
 - e. Thermostats used with all type heaters shall be coordinated with the unit manufacturer for compatibility with equipment.



- f. Acceptable manufacturers subject to compliance with the specifications shall be as follows.
 - i. Sterling
 - ii. Trane
 - iii. Modine
 - iv. Vulcan
 - v. Airtherm
 - vi. Sigma

- 2. Cabinet Unit Heaters
 - a. Steam or Hot water
 - i. Acceptable manufacturers subject to compliance with the specifications shall be as follows.
 - 1. Sterling
 - 2. Trane
 - 3. Modine
 - 4. Vulcan
 - 5. Airtherm

- 3. Fan Coil Units
 - a. Provide horizontal or vertical fan coil units where shown and indicated on the drawings. Unit capacities shall be certified in compliance with Air Conditioning and Refrigeration Institute Standard 440-81. Units shall be UL listed under the Re-Examination Service.
 - b. Acceptable manufacturers subject to compliance with the specifications shall be as follows:
 - i. Airtherm
 - ii. Trane
 - iii. Carrier
 - iv. York
 - v. International Fan Coil
 - vi. Williams
 - c. All new FCUs shall be provided with ECM motors and the appropriate Siemens controller.
 - d. All ECM motors need to accept a 0-10 speed input signal.
 - e. Filter and motor access shall be coordinated during design phase.
 - f. Reference BAS standard for water bugs (overflow sensors) in drain pans.



- i. Ceiling hung fan coil units require a liquid high level sensor in the drain pan per the Mechanical code. The sensor shall be provided by the fan coil unit manufacturer which will be tied to the BAS for alarm.
4. The basic unit shall be fabricated of 18 gauge galvanized steel. Provision for hanging the unit shall be provided by slots in the top wrap of the basic housing. The standard arrangement shall be furnished with a 1 inch discharge duct collar with extended collars furnished where shown with ductwork.
5. Finned Tube Radiation
- a. Acceptable manufacturers subject to compliance with the specifications shall be as follows:
 - i. Vulcan
 - ii. Sterling
 - b. Radiation shall have net I=B=R approved ratings in accordance with the Hydronics Institute "Testing and Rating Standard for Finned Tube Radiation".
 - c. Heating Elements (Typical All Radiation Types)
 - i. Heating elements shall be steel or copper/aluminum supported at 4'-0" intervals with a wall mounted slide-cradle type hanger. Provide additional horizontal pipe hangers as required.
6. Radiant Heating Panels
- a. Provide a radiant heating panel system as indicated on the drawings and connect to hot water piping.
 - b. Acceptable manufacturers subject to compliance with the specifications shall be as follows:
 - i. Price
 - ii. Sun-El
 - iii. Sterling
 - iv. Airtex
 - v. Airtite
 - c. Performance data and dimensional specifications shall be available from the manufacturer for all products. Performance and capacity data shall be based on testing performed by the manufacturer or confirmed by a testing laboratory recognized in the Industry.
7. Chilled beams



- a. Chilled beams shall be considered as a design option for cooling of laboratories, common areas, offices and other suitable spaces.
- b. Chilled beams will not be acceptable in labs where the required fume hood makeup air is enough to satisfy the peak cooling load.



25 0510 Existing Building Automation System (BAS) Description

1. Armenise Building

a. BAS Vendor

i. Siemens

b. Communication

i. P2, Ethernet, BACnet

c. Systems

i. Cooling

1. D1 Chilled Water: Serves AHU's. Electronic valve actuation. (2) pumps on VFD's. DP control.
2. D2 Chilled Water: Serves FCU's. Pneumatic valve actuation and bypass. (2) pumps on VFD's.
3. Condenser Water Control: (2) pumps on starters (?). Bypass valve, emergency city water supply controlled by pneumatic actuation by pressure.

ii. Heating

1. HTX-1 (2) steam HEX. On/Off via outside air temperature. Pneumatic valve actuation. (4) pumps on starters. DP control.
2. HTX-2 (2) steam HEX. On/Off via outside air temperature. Pneumatic valve actuation. (4) pumps on starters. DP control.
3. Heat Recovery: Pump on starter. Mixing valve pneumatic actuation.
4. Snow Melt: roof snow melt system.

iii. AHU's

1. AHU-1. Capacity XX CFM: 100% outside air unit. All electronic actuation. Preheat (LPS) enabled by outside air temperature. Chilled water coil. Hot water reheat coil. Humidification (LPS). Fan on VFD.



2. AHU-2. Capacity XX CFM: 100% outside air unit. All electronic actuation. Preheat (LPS) enabled by outside air temperature. Chilled water coil. Hot water reheat coil. Humidification (LPS). Fan on VFD.
3. AHU-3. Capacity XX CFM: 100% outside air unit. All electronic actuation. Preheat (LPS) enabled by outside air temperature. Chilled water coil. Hot water reheat coil. Humidification (LPS). Fan on VFD.
4. AHU-4. Capacity XX CFM: 100% outside air unit. All electronic actuation. Preheat (LPS) enabled by outside air temperature. Chilled water coil. Hot water reheat coil. Humidification (LPS). Fan on VFD.
5. AHU-5. Capacity XX CFM: 100% outside air unit. All electronic actuation. Preheat (LPS) enabled by outside air temperature. Chilled water coil. Hot water reheat coil. Humidification (LPS). Fan on VFD.
6. AHU-2. Capacity XX CFM: Mixed air unit. Supply/Return fans. All electronic actuation. Preheat (LPS). Chilled water coil. Humidification (LPS). Fans on VFD's.
7. AC-6. Capacity XX CFM: Mixed air unit. Supply and return fans on starter. Pneumatic actuation. Chilled water coil. Hot water reheat coil.
8. AHU-1. Capacity XX CFM: 100% outside air unit. Electronic actuation. Preheat (HW) Glycol (?). Chilled water coil. Reheat (LPS). Humidification (LPS). Fan on VFD.
9. AHU-10. Capacity XX CFM: 100% outside air unit. Electronic actuation. Preheat (LPS). Chilled water coil. Reheat (LPS). Fan on VFD.
10. AC-3. Capacity XX CFM: 100% outside air unit. Electronic actuation. Preheat (HW) Glycol (?). Chilled water coil. Reheat (LPS). Humidification (LPS). Fan on VFD.
11. MAU-1. Capacity XX CFM: 100% outside air unit. Electronic actuation. Preheat (HW) Glycol (?). No cooling. Reheat (LPS). Fan on VFD.
12. AC-9. Capacity XX CFM: Mixed air unit. Supply and return fans on VFD's. Electronic actuation. Preheat (HW) coil. Chilled water coil.

iv. Exhaust Fans

1. 5th floor DI side General: Fan on VFD. Control not shown.
2. 1st floor DI side General: Fan on VFD. Control not shown.

2. Building C



- a. BAS Vendor
 - i. Siemens
- b. Communication
 - i. P2, Ethernet, BACnet
- c. Systems
 - i. Cooling:
 - 1. HOG ELEC CW: Pneumatic actuation. (4) pumps on VFD', staged operation, DP control.
 - ii. Heating:
 - 1. HTX-1 steam HEX. On/Off via outside air temperature. Pneumatic valve actuation. Pumps on VFD. DP control.
 - 2. Heat Recovery: Pneumatic control. Pump on starter.
 - iii. AHU's:
 - 1. AHU-1 Supply. Capacity XX CFM: 100% outside air unit. All electronic actuation. Preheat (LPS) enabled by outside air temperature. Chilled water coil. Reheat (LPS) coil. Humidification (LPS). Fans on VFD.
 - 2. MAHU-1 Supply. Capacity XX CFM: 100% outside air unit. All electronic actuation. Preheat (LPS) enabled by outside air temperature. No cooling. Humidification (LPS). Fans on VFD.
 - 3. AC-1 Supply. Capacity XX CFM: 100% outside air unit. All pneumatic actuation. Preheat (LPS) enabled by outside air temperature. Chilled water coil. Reheat (LPS) coil. Fan on VFD.
 - 4. AC-5. Capacity XX CFM: Room return only unit. Electronic actuation. Chilled water coil. Room temperature control.
 - 5. AC-6. Capacity XX CFM: 100% outside air unit. All electronic actuation. Preheat (LPS) with face and bypass damper. Chilled water coil. Reheat (LPS) coil. Fan on VFD. Room temperature averaged control.
 - 6. MA-1. Capacity XX CFM: 100% outside air unit. Pneumatic actuation. Preheat and Reheat (HW). Reheat pneumatically controlled. Fan on VFD.



7. MA-7. Capacity XX CFM: 100% outside air unit. All electronic actuation. Preheat (LPS) coil. Chilled water coil. Reheat (LPS) coil. Fans on VFD.
 - iv. Exhaust Fans:
 1. EF-6: Static control. Fan on VFD.
 2. EF-7 (Hood Exhaust): Fan on VFD. Static pressure control.
3. Countway Library
 - a. BAS Vendor
 - i. Siemens
 - b. Communication
 - i. P2, Ethernet
 - c. Systems
 - i. Cooling:
 1. Chilled water system: Pneumatic control and actuation. Deny valve. (2) Pumps on VFD.
 - ii. Heating:
 1. HX-1: Steam HEX outside air temperature control. Pneumatic actuation. (2) Pumps on starters.
 - iii. AHU's:
 1. AHU-1. Capacity XX CFM: Mixed air unit. Supply/return fan on VFD. Pneumatic control and actuation. No heating. Chilled water coil. Humidification.
 2. AHU-2. Capacity XX CFM: Mixed air unit. Supply/return fan on VFD. Pneumatic control and actuation. No heating. Chilled water coil. Humidification.
 3. AHU-3. Capacity XX CFM: Mixed air unit. Fan on starter. Pneumatic control and actuation. Preheat (HW) coil. Chilled water coil. Reheat (HW) Coil. Humidification.



4. AHU-4. Capacity XX CFM: Mixed air unit. Fan on starter. Pneumatic control and actuation. Chilled water coil. Reheat (HW) Coil. Humidification.
5. AHU-5. Capacity XX CFM: Mixed air unit. Fan on starter. Pneumatic control and actuation. Chilled water coil. Reheat (HW) Coil. Humidification.

iv. Exhaust Fans: No information.

4. Goldenson Building

a. BAS Vendor

i. Siemens

b. Communication

i. P2, Ethernet, BACnet

c. Systems

i. Cooling:

1. Building Chilled Water: Electronic actuation. Deny valve. (2) Pumps on VFD. Staged operation, fault detection, DP control.

ii. Heating:

1. HTX-1 steam HEX. On/Off via outside air temperature. Pneumatic valve actuation. Pumps on starter.

iii. AHU's:

1. AHU-1 Supply. Capacity XX CFM: 100% outside air unit. All electronic actuation. Preheat (LPS) enabled by outside air temperature. Chilled water coil. Reheat (LPS) coil.
2. AHU-2 Supply. Capacity XX CFM: 100% outside air unit. All electronic actuation. Preheat (LPS) enabled by outside air temperature. Chilled water coil. Reheat (LPS) coil.
3. AHU-3 Supply. Capacity XX CFM: 100% outside air unit. All electronic actuation. Preheat (LPS) enabled by outside air temperature. Chilled water coil. Reheat (LPS) coil.



4. AHU-4 Supply. Capacity XX CFM: 100% outside air unit. All electronic actuation. Preheat (LPS) enabled by outside air temperature. Chilled water coil. Reheat (LPS) coil.
5. AHU-5 Supply. Capacity XX CFM: 100% outside air unit. All electronic actuation. Preheat (LPS) enabled by outside air temperature. Chilled water coil. Reheat (LPS) coil.
6. AHU-6 Supply. Capacity XX CFM: 100% outside air unit. All electronic actuation. Preheat (LPS) enabled by outside air temperature. Chilled water coil. Reheat (LPS) coil.
7. AHU-7: Demolished
8. AHU-8 Supply. Capacity XX CFM: Mixed air unit. DX cooling. Electric heat. Humidification (LPS) electronic.
9. MAU-01. Capacity XX CFM: 100% outside air unit. Reheat (LPS). Electronic actuation.
10. MAU-02. Capacity XX CFM: 100% outside air unit. Reheat (LPS). Electronic actuation.
11. MAU-03. Capacity XX CFM: 100% outside air unit. Preheat (LPS). Reheat (LPS). Electronic actuation.
12. MAU-04. Capacity XX CFM: 100% outside air unit. Preheat (LPS). Reheat (LPS). Electronic actuation.
13. AHU-01A. Capacity XX CFM: Mixed air unit. Electronic actuation. Chilled water coil. Reheat (LPS). Humidification.
14. AHU-09. Capacity XX CFM: 100% outside air unit. Electronic actuation. Preheat (HW) coil. Chilled water coil. Reheat (LPS). Humidification.

iv. Exhaust Fans:

1. EXF-1: NMR Lab 145 EXF. Operated with panic button.
2. EXF-2 & 3: General Lab Exhaust. Static pressure control.

5. Gordon Hall

a. BAS Vendor

i. Siemens



- b. Communication
 - i. P2, Ethernet
- c. Systems
 - i. Cooling
 - 1. Building Chilled Water: Chilled water deny valve control. Electronic valve actuation. Pumps on VFD's. DP control.
 - ii. Heating
 - 1. HTX-1 steam HEX. On/Off via outside air temperature. Electronic valve actuation. Pumps on VFD's. DP control.
 - iii. AHU's
 - 1. SPF: Stairwell pressurization fan
 - 2. AHU-2. Capacity XX CFM: Mixed air unit. Supply/Return fans. Chilled water coil. No heat.
 - 3. AHU-3. Capacity XX CFM: Mixed air unit. Supply fan. Chilled water coil. No heat.
 - 4. AHU-5. Capacity XX CFM: 100% Outside air unit. (2) low pressure steam preheat valves. Chilled water coil.
 - 5. MUA-9. Capacity XX CFM: 100% Outside air unit. Hot water preheat and reheat coils. Chilled water coil.
 - 6. AHU-10. Capacity XX CFM: Mixed air unit. Supply/Return fans. Chilled water coil. Hot water coil.
 - 7. AHU-1. Capacity XX CFM 1: Mixed air unit. Supply fan. Chilled water coil. No heat.
 - 8. AHU-12. Capacity XX CFM: Mixed air unit. Supply fan. Chilled water coil. No heat.
 - iv. Exhaust Fans
 - 1. Atrium Exhaust
- 6. Harvard Institutes of Medicine (HIM)



- a. BAS Vendor
 - i. Johnson Controls.
- b. Communication
 - i. P2, Ethernet, BACnet
- c. Systems
 - i. Cooling
 - 1. Process CHW System: Chilled water deny valve control. Electronic valve actuation. (2) Pumps on starters. Staged control by DP and Lead/Lag. Bypass valve.
 - 2. AHU CHW System: Chilled water deny valve control. Electronic valve actuation. (2) Pumps on VFD's. Staged control by DP and Lead/Lag. Bypass valve.
 - 3. FCU CHW System: Chilled water deny valve control. Electronic valve actuation. (2) Pumps on VFD's. Staged control by DP and Lead/Lag. Bypass valve.
 - ii. Heating
 - 1. Lab reheat
 - a. 2 pumps on VFD's, DP control, lead/lag program.
 - 2. Animal reheat
 - a. 2 pumps on VFD's, DP control, lead/lag program.
 - 3. Glycol Heat Recovery
 - a. 2 pumps on VFD's, DP control, lead/lag program. Bypass valve electronic actuation.
 - iii. AHU's
 - 1. AHU-1. Capacity XX CFM: 100% outside air unit. Electronic actuation. Heat recovery coil. Preheat (HW). Chilled water coil. Humidification (LPS). Fan on VFD.



2. AHU-2. Capacity XX CFM: 100% outside air unit. Electronic actuation. Heat recovery coil. Preheat (HW). Chilled water coil. Humidification (LPS). Fan on VFD.
 3. AHU-3. Capacity XX CFM: 100% outside air unit. Electronic actuation. Heat recovery coil. Preheat (HW). Chilled water coil. Humidification (LPS). Fan on VFD.
 4. AHU-4. Capacity XX CFM: 100% outside air unit. Electronic actuation. Heat recovery coil. Preheat (HW). Chilled water coil. Humidification (LPS). Fan on VFD.
 5. AHU-5. Capacity XX CFM: 100% outside air unit. Electronic actuation. Heat recovery coil. Preheat (HW). Chilled water coil. Humidification (LPS). Fan on VFD.
 6. AHU-6. Capacity XX CFM: 100% outside air unit. Electronic actuation. Heat recovery coil. Preheat (HW). Chilled water coil. Humidification (LPS). Fan on VFD.
 7. AHU-7. Capacity XX CFM: 100% Return air unit. Electronic actuation. No heat. Chilled water coil. Fan on starter.
 8. AHU-8. Capacity XX CFM: 100% Return air unit. Electronic actuation. No heat. Chilled water coil. Fan on starter.
 9. HVU-1. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Reheat (Medium Unknown). No cooling. Fan on starter.
 10. HVU-2. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Reheat (Medium Unknown). No cooling. Fan on starter.
 11. HVU-3. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Reheat (Medium Unknown). No cooling. Fan on starter.
 12. HVU-4. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Reheat (Medium Unknown). No cooling. Fan on starter.
- iv. Exhaust Fans
1. EX-1: Fan on starter. Room temperature control with isolation damper proof.
 2. EX-2: Fan on starter. Room temperature control with isolation damper proof.



3. EX-3: Fan on starter. Room temperature control with isolation damper proof.
4. EX-4: Fan on starter. Room temperature control with isolation damper proof.
5. EAHU-1: Heat recovery coil. 2 fans on VFD.
6. EAHU-2: Heat recovery coil. 2 fans on VFD.
7. EAHU-3: Heat recovery coil. 2 fans on VFD.
8. EAHU-4: Heat recovery coil. 2 fans on VFD.
9. EAHU-5: Heat recovery coil. 1 fan on VFD.
10. EAHU-6: Heat recovery coil. 1 fan on VFD.
11. EAHU-7: Heat recovery coil. 1 fan on VFD.

7. Laboratory for Human Reproduction and Reproductive Biology (LHRRB)

a. BAS Vendor

- i. Siemens

b. Communication

- i. P2, Ethernet.

c. Systems

i. Cooling

1. Chilled water deny valve control. Electronic valve actuation. (2) Pumps on starters. Staged control by DP and Lead/Lag.

ii. Heating

1. HX-1: Pneumatic control and actuation. Pump on starter.

iii. AHU's

1. AHU-1. Capacity XX CFM: 100% outside air unit. Pneumatic actuation. Chilled water coil. Reheat (LPS). Humidification. Fan on starter.



2. AHU-3. Capacity XX CFM: 100% outside air unit. Pneumatic actuation. Chilled water coil. Reheat (LPS). Humidification. Fan on starter.
3. HV-1. Capacity XX CFM: 100% outside air unit. Pneumatic actuation. No cooling. Reheat (LPS). Humidification. Fan on VFD.
4. AC-4. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Chilled water coil. Reheat (LPS). Fan on multi state starter.

iv. Exhaust Fans

1. No fans indicated.

8. New Research Building (NRB)

a. BAS Vendor

- i. Siemens

b. Communication

- i. P2, Ethernet, BACnet

c. Systems

i. Cooling

1. Process Cooling System: Electronic Actuation. Cooling tower fans on VFD's. Condenser water pumps on starter. Chilled water pumps on VFD's, DP control. Bypass valve.
2. 4600 ton Chiller Plant.

ii. Heating

1. HE-1 / HE-2: Steam HEX. Electronic actuation. (2) Pumps on VFD's. DP control. DP valve.
2. HE-3 / HE-4: Steam HEX. Electronic actuation. (2) Pumps on VFD's. DP control. DP valve.
3. HE-5 / HE-6: Steam HEX. Electronic actuation. (2) Pumps on VFD's. DP control. DP valve.
4. HE-7 / HE-8: Steam HEX. Electronic actuation. (2) Pumps on starters. DP control. DP valve.



5. HE-9 / HE-10: Steam HEX. Electronic actuation. (3) Pumps on VFD's. DP control. DP valve. Isolation valves.

iii. AHU's

1. AHU-1. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Preheat (HW). Chilled water coil. Humidification (LPS). Fans (2) on VFD's.
2. AHU-2. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Preheat (HW). Chilled water coil. Humidification (LPS). Fans (2) on VFD's.
3. AHU-3. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Preheat (HW). Chilled water coil. Humidification (LPS). Fans (2) on VFD's.
4. AHU-4. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Preheat (HW). Chilled water coil. Humidification (LPS). Fans (2) on VFD's.
5. AHU-5. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Preheat (HW). Chilled water coil. Humidification (LPS). Fans (2) on VFD's.
6. AHU-6. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Preheat (HW). Chilled water coil. Humidification (LPS). Fans (2) on VFD's.
7. AHU-7. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Preheat (HW). Chilled water coil. Humidification (LPS). Fans (2) on VFD's.
8. AHU-8. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Preheat (HW). Chilled water coil. Humidification (LPS). Fans (2) on VFD's.
9. AHU-9. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Preheat (HW). Chilled water coil. Humidification (LPS). Fans (2) on VFD's.
10. AHU-10. Capacity XX CFM: Mixed air unit. Electronic actuation. Chilled water coil. Reheat (LPS). Supply fans (2) on VFD's.
11. AHU-11. Capacity XX CFM: Mixed air unit. Electronic actuation. Chilled water coil. Reheat (LPS). Supply and Return fans on VFD's.
12. AHU-12. Capacity XX CFM: Mixed air unit. Electronic actuation. Chilled water coil. Reheat (LPS). Supply and Return fans on VFD's.
13. AHU-14. Capacity XX CFM: Return air unit. Electronic actuation. Chilled water coil. No heat.
14. AHU-15. Capacity XX CFM: Return air unit. Electronic actuation. Chilled water coil. No heat.



15. HVU-1. Capacity XX CFM: 100% outside air unit. Preheat (LPS). No cooling. Fan on starter.
16. HVU-2. Capacity XX CFM: 100% outside air unit. Preheat (LPS). No cooling. Fan on starter.
17. HVU-3. Capacity XX CFM: 100% outside air unit. Preheat (LPS). No cooling. Fan on starter.
18. HVU-4. Capacity XX CFM: 100% outside air unit. Preheat (LPS). No cooling. Fan on starter.
19. HVU-5. Capacity XX CFM: 100% outside air unit. Preheat (LPS). No cooling. Fan on starter.
20. The following supply fan (SF) are on starters: 2 through 5, 7, 11, 15, 21, 24 through 32.
21. The following supply fans (SF) are on VFD's: 12, 13, 14, 16 through 20, 22, 23.
22. VU-1: 100% outside air unit. Fan on VFD.
23. VU-2: 100% outside air unit. Fan on VFD.

iv. Exhaust Fans

1. The following fans (EF) are on starters: 2, 3, 4, 5, 6, 11, 26.
2. The following fans (EF) are on VFD's: 7, 12, 13, 14, 15, 16, 17, 36, 37.

9. Seeley G. Mudd

a. BAS Vendor

i. Siemens

b. Communication

i. P2, Ethernet

c. Systems

i. Cooling

1. Chilled water deny valve control. Electronic valve actuation. (2) Pumps on starters. Staged control by DP and Lead/Lag.



ii. Heating

1. HX-1 FCU: Steam HEX (2) valves. Pneumatic Control and actuation. (2) Pump on starter.
2. HX-2 Building Reheat: Steam HEX (2) valves. Pneumatic Control and actuation. (2) Pump on starter.
3. Glycol Hot Water System: (2) Steam HEX's each with (2) steam supply valves. Electronic actuation. (2) Pumps on VFD's.

iii. AHU's

1. AHU-1. Capacity XX CFM: 100% outside air unit. Electronic actuation. Preheat (HW). Chilled water coil. Humidification (LPS). (3) Fans on VFD's.
2. AHU-2. Capacity XX CFM: 100% outside air unit. Electronic actuation. Preheat (HW). Chilled water coil. Humidification (LPS). (3) Fans on VFD's.
3. AHU-4. Capacity XX CFM: 100% outside air unit. Preheat (HW) electronic control. Chilled water pneumatic control. Reheat (HW) pneumatic control. Humidification electronic control. Fan on VFD.
4. AHU-5. Capacity XX CFM: 100% outside air unit. Preheat (HW) electronic control. Chilled water pneumatic control. Reheat (HW) pneumatic control. Humidification electronic control. Fan on VFD.
5. MA-6. Capacity XX CFM: Pneumatic control. Preheat (LPS). Chilled water coil. Fan on starter.
6. MA-8. Capacity XX CFM: Pneumatic control. Preheat (LPS). Chilled water coil. Reheat (HW). Humidification (LPS). Fan on starter.

iv. Exhaust Fans

1. Nothing listed.

10. Tosteson Medical Education Center (TMEC)

a. BAS Vendor

i. Siemens

b. Communication

i. P2, Ethernet



c. Systems

i. Cooling

1. Building Chilled Water: Return temperature control. Mix valve control unknown. Pump on VFD.
2. Building Chilled Water Fire Pump Room: Electronic actuation. VFD has all failed points.

ii. Heating

1. HX-1: Steam HEX. Pneumatic actuation. Outside air temperature control. Pumps on VFD.
2. HX-1: Steam HEX. Pneumatic actuation. Outside air temperature control. Pumps on VFD.
3. HX-1 Baseboard: Steam HEX. Steam valve electronic actuation. Bypass valve pneumatic actuation. Outside air temperature control. Pumps on starter.
4. HX-2 Reheats: Steam HEX. Steam valve electronic actuation. Bypass valve pneumatic actuation. Outside air temperature control. Pumps on starter.

iii. AHU's

1. AHU-1 Basement. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Preheat (LPS). Chilled water coil. Humidification. (2) Fans on VFD's.
2. AHU-2 Basement. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Preheat (LPS). Chilled water coil. Humidification. (2) Fans on VFD's.
3. AHU-3 Basement. Capacity XX CFM: 100% Outside air unit. Electronic actuation. Preheat (LPS). Chilled water coil. Humidification. (2) Fans on VFD's.
4. AHU-4 Basement. Capacity XX CFM: Mixed air unit. Electronic actuation. Preheat (LPS). Chilled water coil. Supply and return fans on VFD's.
5. SF-1 E MUA-0001. Capacity XX CFM: Fan controlled by vanes. Supplies air to AHU-1, 2, 3 & 4.



6. AHU-1 Penthouse. Capacity XX CFM: Mixed air unit. Pneumatic actuation. Energy recovery. Preheat (LPS) face and bypass. Chilled water coil. Supply and return fans on VFD's.
7. AHU-2 Penthouse. Capacity XX CFM: Mixed air unit. Pneumatic actuation. Preheat (LPS) face and bypass. Chilled water coil. Supply and return fans on VFD's.
8. AHU-3 Penthouse Atrium Fan. Capacity XX CFM: Mixed air unit. Pneumatic actuation. Preheat (LPS) face and bypass. Chilled water coil. Supply and return fans on VFD's.

iv. Exhaust Fans

1. EXF-2: Fan on VFD controlled by static pressure.
2. EXF-5: Fan on VFD controlled by static pressure.
3. EXF-34: Fan on VFD controlled by static pressure.

11. Vanderbilt Hall

a. BAS Vendor

i. Siemens

b. Communication

i. P2, Ethernet

c. Systems

i. Cooling

1. Chilled Water System: Pneumatic Control and actuation. (2) Deny valves. (2) Pumps on VFD's. (2) Pumps on starters.
2. IT Department Chilled Water System: Pneumatic control and actuation. DP sensors. (2) Pumps on staged VFD's.

ii. Heating

1. HX-1: Pneumatic actuation. Steam supply (LPS).
2. HX-2: Pneumatic actuation. Steam supply (LPS).
3. HX-3: Pneumatic actuation. Steam supply (LPS).



4. HX-4: Pneumatic actuation. Steam supply (LPS). (2) staged pumps on starters.

iii. AHU's

1. AHU-1. Capacity XX CFM: Mixed air unit. Preheat (HW) electronic control. Chilled water pneumatic control. Supply and return fans on starters.
2. AHU-2. Capacity XX CFM: Mixed air unit. Preheat (HW) pneumatic control. Chilled water pneumatic control. Supply and return fans on starters.
3. AHU-3. Capacity XX CFM: Mixed air unit. Preheat (HW) pneumatic control. Chilled water pneumatic control. Supply and return fans vanes on pneumatic control.
4. AHU-5. Capacity XX CFM: 100% outside air unit. Bypass damper electronic control. DX cooling 2 stages. Reheat (LPS). Fan on VFD.
5. HV-1. Capacity XX CFM: 100% outside air unit. Reheat (LPS) pneumatic control. No cooling. Fan on starter.
6. HV-2. Capacity XX CFM: 100% outside air unit. Reheat (LPS) pneumatic control. No cooling. Fan on starter.
7. HV-4. Capacity XX CFM: 100% outside air unit. Reheat (LPS) pneumatic control. No cooling. Fan on starter.
8. HV-5. Capacity XX CFM: 100% outside air unit. Reheat (LPS) pneumatic control. No cooling. Fan on starter.

iv. Exhaust Fans

1. None listed.

12. Warren Alpert Building

- a. BAS Vendor
 - i. Siemens
- b. Communication
 - i. P2, Ethernet, BACnet.
- c. Systems



i. Cooling

1. Chilled Water Basement / MATEP: (2) Pumps on VFD staged operation. Fault detection. DP control.
2. Chilled Water Independent McQuay: Roof McQuay Chillers. (3) pumps on VFD. (3) Mech chillers.
3. Cooling Towers: Pneumatic bypass. (2) Pumps on starters. Tower fans on VFD. Backup Plate & Frame HEX.

ii. Heating

1. HX-1 Radiation: (2) Steam supply valves pneumatic control. (2) Pumps on starters. Bypass valve electronic actuation.
2. HX-2 Animal: (2) Steam supply valves pneumatic control. (2) Pumps on starters. Bypass valve pneumatic actuation.
3. HX-3 Lab Reheat: (2) Steam supply valves pneumatic control. (2) Pumps on starters. Bypass valve pneumatic actuation.
4. Heat Recovery System: (2) Pumps on starters. Mixing valve pneumatic control.

iii. AHU's

1. AHU-1. Capacity XX CFM: 100% outside air unit. Electronic actuation. Preheat (LPS). Chilled water coil. Fan wall on VFD's (4).
2. AHU-2. Capacity XX CFM: 100% outside air unit. Electronic actuation. Preheat (LPS). Chilled water coil. Fan wall on VFD's (4).
3. AHU-3. Capacity XX CFM: 100% outside air unit. Preheat (LPS) electronic actuation. Chilled water pneumatic. (2) Humidifier valves pneumatic control. (2) Fans on VFD's.
4. AHU-4. Capacity XX CFM: 100% outside air unit. Electronic actuation. Preheat (LPS). Chilled water coil. Fan wall on VFD's (4).
5. AHU-5. Capacity XX CFM: 100% outside air unit. Pneumatic control. Preheat (LPS). Chilled water coil. (2) Humidifier valves. Fan control by vanes.
6. AHU-6. Capacity XX CFM: 100% outside air unit. Pneumatic control. Preheat (LPS). Chilled water coil. (2) Humidifier valves. Fan control by vanes.



7. AHU-7. Capacity XX CFM: Mixed air unit. Pneumatic control. Preheat (LPS). Chilled water coil. Reheat (LPS). Supply and return fans on VFD's.
8. HV-1. Capacity XX CFM: 100% Outside air unit. Pneumatic control. Preheat (LPS). No cooling. Fan on starter.

iv. Exhaust Fans

1. EAHU-1. Capacity XX CFM: Fan wall with 12 fans on VFD. Heat recovery coil.
2. EAHU-2. Capacity XX CFM: Fan wall with 12 fans on VFD. Heat recovery coil.
3. EAHU-3. Capacity XX CFM: Fan wall with 12 fans on VFD. Heat recovery coil.
4. EAHU-4. Capacity XX CFM: Fan wall with 12 fans on VFD. Heat recovery coil.
5. EAHU-5. Capacity XX CFM: Fan control with pneumatic vanes. Heat recovery coil.
6. EAHU-6. Capacity XX CFM: Fan wall with 12 fans on VFD. Heat recovery coil.
7. Garage Exhaust: Fan on starter.
8. Cage Wash: (2) fans on starter.

13. 158 Longwood Avenue

- a. No BAS in building.

14. 160-164 Longwood Avenue

- a. No BAS in building.

15. 180 Longwood Avenue

- a. BAS Vendor
 - i. Siemens.
- b. Communication
 - i. P2, Ethernet.



c. Systems

i. Cooling

1. AHU Chilled Water: Pneumatic actuation. Pumps on VFD's with staged control.
2. FCU Chilled Water: Pneumatic actuation. DP. Pumps on VFD's.

ii. Heating

1. HX-1: Steam HEX. Pneumatic actuation. Outside air temperature controlled. Pumps on VFD's.
2. HX- 2/3 ARC: High pressure steam HEX. Pneumatic actuation. Line TE controlled with reset by outside air temperature. Pumps staged on starters. DP sensor and bypass valve regulate pressure.

iii. AHU's

1. AHU-1. Capacity XX CFM: 100% Outside air unit, McQuay packaged unit. Preheat (LPS) control not on graphic. Mechanical cooling 2 staged compressors.
2. AHU-2. Capacity XX CFM: 100% Outside air unit. Pneumatic actuation. Preheat (LPS) face and bypass. Chilled water coil. Fan on starter (?).
3. AHU-4. Capacity XX CFM: Mixed air unit. Electronic actuation. Preheat (LPS). Chilled water coil. Humidifier is shut down and said not to be used.

iv. Exhaust Fans

1. EF-1: Fan on starter.
2. EF-2: Fan on starter.
3. EF-3: Fan on starter.

16. 641 Huntington Avenue

a. BAS Vendor

i. Siemens

b. Communication



- ii. P2, Ethernet.
- c. Systems
 - iii. Cooling
 - 1. Electronic actuation. Outside air temperature enabled. DP control with bypass valve. (2) Pumps on VFD's.
 - iv. Heating
 - 1. Steam Boiler System: Electronic actuation. 2 city water feed valves. 2 condensate pumps on starters.
 - 2. Hot Water System: DP sensor. (2) Pumps on VFD's.
 - v. AHU's
 - 1. ERU1. Capacity XX CFM: Electronic actuation. Heat wheel motor VFD. Bypass damper. Chilled water coil. Reheat (HW). Supply and Return fans on VFD's.
 - 2. Fresh Air Damper 201: Outside air / program enabled for FCU 201.
 - 3. Fresh Air Damper 301: Outside air / program enabled for FCU 301.
 - 4. Fresh Air Damper 312: Outside air / program enabled for FCU 312.
 - 5. Fresh Air Damper 401: Outside air / program enabled for FCU 401.
 - vi. Exhaust Fans
 - 1. EF-2: Fan on starter.
 - 2. EF-3: Fan on starter.

17. School of Dental Medicine

- a. BAS Vendor
 - i. Siemens
- b. Communication
 - i. P2, Ethernet
- c. Systems



i. Cooling

1. Chilled Water System: (2) DP sensors. (2) Pumps on VFD's.
2. Main Building Chilled Water System: DP sensor. Deny valve. Pneumatic control.

ii. Heating

1. HX-1: Steam HEX. Pneumatic control. Bypass valve. (2) Staged pumps on starters.
2. 2nd Floor Radiation: Electronic mixing valve. (2) staged pumps on starters.
3. HX-3: Steam HEX. Pneumatic control and actuation. Steam supply valves two position. Isolation valves. (2) pumps on starters.

iii. AHU's

1. AHU-1. Capacity XX CFM: Mixed air unit. Pneumatic control. Preheat (LPS). Chilled water coil. Supply and return fans on VFD's.
2. AHU-2. Capacity XX CFM: Mixed air unit. Pneumatic control. No heat. Chilled water coil. Supply and return fans on VFD's.
3. Malony AHU. Capacity XX CFM: Mixed air unit. Preheat (HW) electronic. Chilled water control not shown. Unit temperature controlled. Fan on starter.

iv. Exhaust Fans

1. None listed.

18. Research and Education Building (REB)

a. BAS Vendor

i. Siemens

b. Communication

ii. P2, Ethernet, BACnet.

c. Systems

iii. Cooling



1. Chilled Water Pumps Basement: DP Sensor. Ultrasonic Energy Meter. (2) Pumps on VFD's.

iv. Heating

1. HX-1/2: Steam HEX. Electronic actuation. Outside air temperature control. (2) Pumps on VFD's.
2. Glycol Heat Recovery EAU1 Coil: Steam HEX. Electronic actuation. Outside air temperature enabled. Bypass valve. Pumps on starter.

v. AHU's

1. AHU-1: Basement 100% outside air unit. Electronic actuation. Preheat (LPS). Chilled water coil. Humidification. Fans on VFD.
2. AHU-2: Mixed air unit. Electronic actuation. Preheat (LPS). Chilled water coil. Humidification. Supply and return fans on VFD.
3. HVU-1: Heat unknown. Humidification electronic. Supply fan on VFD.
4. Stair 1 / 2PO1C Pressure Fans: HVU-1 on starter (?). EX-07 on starter. SF-3 on starter. SF-2 on starter.

vi. Exhaust Fans

1. EAHU-1. Capacity XX CFM: Electronic actuation. Heat recovery coil. Outside air relief damper. (2) Fans on starters.
2. EF 3 / 4: Penthouse / Emergency Electric Room ventilation. Temperature control. Fan on starter.
3. EF 5 / 6 / 7: Toilet, Stairwell pressure, Smoke vestibules. Fans on starters.
4. EF 8 / 9: 8 basement electric room ventilation on drive temperature control. Penthouse Necropsy table fan on starter.
5. EF 10 / 11 / 12: 10 – Radio Isotope hood on drive. 11 – Histology fume hood on starter. 12 – Penthouse MER on starter.



25 0520 Building Automation System (BAS) Design Criteria

1. Design Statement

- a. During the various design phases of this project, the Engineer will develop options and strategies for selection of the appropriate Building Automation System (BAS). This approach will enable the entire Design Team (Owner, Architect and Engineer) to partake in the decision making process concerning the selection of the BAS infrastructure.
- b. The new BAS shall have the following characteristics:
 - i. Vendor shall be Siemens Building Technologies
 - ii. BACnet shall be the communication protocol
 - iii. Flexibility for future changes and expansion.
 - iv. Ease of maintenance.
 - v. Robust design.
 - vi. Cost Effectiveness
- c. BAS Commissioning:
 - i. The Design Team shall provide fully integrated design documents to ensure sure all required Contractors are fully responsible for supporting the Commissioning activities for the proposed systems to be commissioned. All required labor hours and materials shall be included for, at a minimum but not limited to meetings, supporting documentation, field testing activities, ancillary testing equipment, off-season testing, data storage, support for 10 month warranty verification (if required), etc.
 - ii. The Design Team shall work with the project Commissioning Agent to incorporate all of their testing requirements into the contract specifications.
- d. Every effort will be made to design, layout and install equipment in locations which will tend to encourage routine preventive maintenance by providing easy access for maintenance personnel.

2. Engineers Control Drawings

- a. Drawings
 - i. Unique flow diagrams with points list and sequence of operation on the drawings.



- b. Point Lists
 - i. Point lists shall provide indication of the following:
 - ii. Point type (AI, AO, BI, BO)
 - iii. Tag name and description
 - iv. Alarming requirements
 - v. Point naming conventions
 - c. Sequence of Operation shall be included on the drawings with the associated flow diagram.
3. Energy:
- a. USGBC/LEED Criteria: Gold certifiable
 - b. Refer to Harvard Green Building Standard
4. Codes, Standards and References
- a. Massachusetts State Building Code
 - b. Massachusetts Electrical Code
 - c. National Fire Protection Association (NFPA)
 - i. NFPA 70 National Electrical Code
 - ii. NFPA 72 National Fire Alarm Code
 - iii. NFPA 101 Life Safety Code
 - d. Underwriters Laboratories (UL)
 - e. Factory Mutual (FM)
 - f. Occupational Safety and Health Administration (OSHA)
 - g. Environmental Protection Agency (EPA)
 - h. Massachusetts Department of Environmental Protection (DEP)
 - i. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - j. American National Standards Institute (ANSI)



5. Contractor Submittal Requirements

- a. Bookmarked pdf format.
- b. Specification Compliance Statement
- c. Network Riser
- d. Flow Diagrams
- e. Sequence of Operation
- f. Graphics
- g. Electrical Load Calculations
- h. Panel layouts
- i. Wiring diagrams
- j. Load shedding programs
- k. Campus HVAC Isolation Program.
- l. Decommissioning plan for existing area to be renovated. This shall include at a minimum for approval prior to any demolition work starting:
 - i. Systems to be decommissioned.
 - ii. Communication pathways that will be interrupted shall be shown on floor plan drawings with device addresses that will be removed.
 - iii. Temporary communication pathways on floor plan drawings that will be required to maintain existing systems during the renovation process.
 - iv. Alarm list showing alarms that will need to be disabled.
 - v. Printouts of software code that will need to be removed.

6. Record Drawings

- a. All items from Contractor Submittal Requirements shall be updated to final installation condition.
- b. Complete alarm summary for project.
- c. Listing of all BACnet addresses for project.



7. Electrical Low Voltage Wiring

- a. Division 26 shall be referenced for installation requirements
- b. If utilized for smoke control application all power and communication wiring shall be in metal raceway.
- c. Conduit in Mechanical/Electrical rooms and shafts.
- d. Above ceiling/in-wall
 - i. Animal Facility spaces
 - 1. In wall conduit.
 - 2. Above ceiling plenum cable provided wiring is accessible.
 - ii. Laboratory spaces
 - 1. In wall plenum cable.
 - 2. Above ceiling plenum cable provided wiring is accessible.
 - iii. Office/Public spaces
 - 1. In wall plenum cable.
 - 2. Above ceiling plenum cable provided wiring is accessible.

8. BAS Architecture

- a. Vendor: Siemens Building Technologies
- b. Basis of design: ASHRAE's BACnet standard
- c. Controller Architecture
 - i. Major Mechanical Equipment (Large AHU's\EAHU's, Chiller Plants, Boiler Plants) shall be IP based controller with direct input/output capability. The controllers shall be tested and listed by the BACnet Testing Laboratory (BTL) as BACnet Building Controllers (B-BC).
 - ii. Small AHU's and Terminal Units shall be IP (Ethernet) based where available. Where IP is not available, MS/TP based controllers shall be provided. The controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Advanced Application Controllers (B-AAC) or as BACnet Application Specific Controllers (B-ASC), depending on the control application.



- iii. No new BACnet devices shall be configured as a BACnet Broadcast Management Device (BBMD). Each building has a BBMD already configured and this shall be utilized.

9. Point naming convention

- a. Points shall be named with the following convention:

- i. "Building Letter. System. Room (as needed) End Device"
- ii. "Building Letter.System-Asset.End Device"
- iii. Examples:

Q.AHU-001.CCV	WAB Air Handler 1 Cooling Coil Valve
Q.HX-003.SP	WAB Heat Exchanger 3 Set Point
Q.316A.FRZ.ALM	WAB 316a Freezer Alarm
Q.205.COLDRM.ALM	WAB 205 Cold Room Alarm
Q.205.COLDRM.TEMP	WAB 205 Cold Room Temp

- b. Terminal unit points will be named with the following convention preceded by the building letter:

- i. For example: "K.AH1.VAV2.317.S"
 1. Serving Air Handler be indicated by A or AH and common number (i.e. AH2 or A12).
 2. Valid Device Types:
 3. FCU – Fan Coil Unit
 4. VAV – Variable Volume Box
 5. RPC – Room Pressurization Controller
 6. FHC - Fume Hood Control
 7. RAD – Radiation Valve
 8. Function should be indicated by:
 9. S - Supply
 10. R - Return / Exhaust
 11. V – Valve
 12. Where there are two or more of the same device serving the same space, a number should be indicated after device type (i.e. VAV1, VAV2, etc)
 13. Add descriptor for all floor level equipment to include CMMS Asset number.

10. Points



- a. Air Handling Units
 - i. All units with outside air connections shall have a low temperature detector (freeze-stat).
 - ii. All units shall have a temperature and humidity element after each coil.
 - iii. All fans shall have proof via an analog current sensor.
 - iv. All filters shall have proof via an analog pressure sensor.
 - v. All units shall have a discharge air temperature and humidity sensor.
 - vi. Each individual fan shall have an air flow station.
 - vii. Each unit shall have a discharge static pressure sensor.
 - viii. Each unit shall have a discharge duct smoke detector.

25 5000 Instrumentation and Terminal Devices

- 1. Sensors and Transmitters
 - a. Preferred Vendors:
- 2. Actuators and Operators
 - a. Preferred Vendors
- 3. Valves and Dampers
 - a. In critical spaces, Belimo valves shall be utilized.
 - b. All valves larger than 2 inches shall be provided with position feedback.
- 4. Meters
 - a. Refer to the HVAC section for Meters.
- 5. Uninterruptible Power Supplies
 - a. Uninterruptible Power Supplies (UPS) shall be listed for Emergency Generator duty and not standard battery backup type.

25 9000 – Sequence of Operation



1. Setpoints

Room Type	Set Points (OCC/UNOCC)	Temp Set Back Control Method	Air Changes per Hour (Occ/Unocc)
Toilet Rooms	Heating - 70F/ -5F Cooling - 75F/ +10F	Setback for fan only, no temp set back	Refer to latest ASHRAE or IECC code for ventilation
Closed Stairways	Heating - 65F, Cooling - 76F	None	Refer to latest ASHRAE or IECC code for ventilation
Open Stair / Main Corridors	Heating - 70F, Cooling - 75F	None	Refer to latest ASHRAE or IECC code for ventilation
Storage Rooms	Heating -65F, Cooling - 78F	None	Refer to latest ASHRAE or IECC code for ventilation
Open Office / Reception	Heating - 70F/ -5F Cooling - 75F/ +10F	Motion	Refer to latest ASHRAE or IECC code for ventilation
Closed Offices	Heating - 70F/ -5F Cooling - 75F/ +10F	Motion	Refer to latest ASHRAE or IECC code for ventilation
Conference Rooms / Break Rooms	Heating - 70F/ -5F Cooling - 75F/ +10F	Motion	Refer to latest ASHRAE or IECC code for ventilation
Classrooms	Heating - 70F/ -5F Cooling - 75F/ +10F	Motion	Refer to latest ASHRAE or IECC code for ventilation
Classrooms	Heating – 69-71F Cooling - 73-78F w/ slide control. 5F deadband required	Motion	Refer to latest ASHRAE or IECC code for ventilation
Commonly Shared spaces	Heating - 70F/ -5F Cooling - 75F/ +10F	Motion	Refer to latest ASHRAE or IECC code for ventilation
Countway Library General Stack Areas	Heating - 70F/ -5F Cooling - 75F/ +10F	Schedule	Refer to latest ASHRAE or IECC code for ventilation
Countway Rare Books	No set back, No change to existing set points.	No set back, No change to existing set points.	Refer to latest ASHRAE or IECC code for ventilation
General Research Labs Metasys	Heating - 70F/ -5F Cooling - 75F/ +10F	Motion	6/4



Room Type	Set Points (OCC/UNOCC)	Temp Set Back Control Method	Air Changes per Hour (Occ/Unocc)
	Common set point with common offset. Will need to schedule by season Heating +/-3 offset Cooling +/- 5 offset		
General Research Labs	Heating – 70F/67F, Cooling - 73/78F	Motion	6/4
All Temperature or Humidity Sensitive Areas - Exempt Research Labs, etc.	No set back, No change to existing set points.	No set back, No change to existing set points.	6/4
All Light Sensitive Areas - Dark Rms, etc	Heating - 70F/ -5F Cooling - 75F/ +10F	Confirm with HMS Facilities	6/4
Animal Rooms	No set back, No change to existing set points.	No set back, No change to existing set points.	8ACH Minimum Confirm with HMS Facilities
Dormitory Rooms	Heating – 69-74F Cooling - 73F-78F w/slide control. 5F deadband required	None	Refer to latest ASHRAE or IECC code for ventilation
Gymnasium	Heating – 70F/67F, Cooling - 73/78F	Schedule	Refer to latest ASHRAE or IECC code for ventilation
Squash Courts	Heating – 70F/67F, Cooling - 73/78F	Schedule	Refer to latest ASHRAE or IECC code for ventilation
Exercise / Weight Rooms	Heating – 70F/67F, Cooling - 73/78F	Schedule	Refer to latest ASHRAE or IECC code for ventilation
Locker Rooms	Heating – 70F/67F, Cooling - 73/78F	Schedule	Refer to latest ASHRAE or IECC code for ventilation
Music Rooms	Heating – 70F/67F, Cooling - 75F/79F	Schedule	Refer to latest ASHRAE or IECC code for ventilation
Worship Rooms	Heating - 70F/ -5F Cooling - 75F/ +10F	Schedule	Refer to latest ASHRAE or IECC code for ventilation
HSDM Clinical Space	Heating - 70F/ -5F Cooling - 75F/ +10F	Schedule	6/4



Room Type	Set Points (OCC/UNOCC)	Temp Set Back Control Method	Air Changes per Hour (Occ/Unocc)
Vanderbilt Clinical Space	Heating - 70F/ -5F Cooling - 75F/ +10F	Schedule	6/4
Elevators	N/A	N/A	N/A
Amphitheatre/Auditorium	Heating - 70F/ -5F Cooling - 75F/ +10F	SET ROOM	Refer to latest ASHRAE or IECC code for ventilation
Mechanical Space	Heating 65F Cooling 78F	N/A	Refer to latest ASHRAE or IECC code for ventilation
Equipment Space	TBD	TBD	Refer to latest ASHRAE or IECC code for ventilation
Kitchens	Heating - 70F/ -5F Cooling - 75F/ +10F	Motion	Refer to latest ASHRAE or IECC code for ventilation
Kitchenettes	Heating - 70F/ -5F Cooling - 75F/ +10F	Motion	Refer to latest ASHRAE or IECC code for ventilation
Dining Rooms	Heating - 70F/ -5F Cooling - 75F/ +10F	Schedule	Refer to latest ASHRAE or IECC code for ventilation
Garages	N/A	N/A	CO/NO2 Sensors

1. General Requirements and Sequences

a. Air Handling Units

- i. Static Pressure Reset routine is required.
- ii. Discharge Air Temperature Reset routine is required.
- iii. Campus HVAC Isolation Program:
 - 1. All controls for new air handling equipment supplying or exhausting air from buildings will be programmed to shut down during initiation of the campus wide Ventilation Emergency Isolation Program.

iv. Load Shedding:

- 1. Unless designated as specialty/exempt, all new / modified areas shall require a modification to the load control / load shedding program as



directed by Facilities, confirmed by E&C. These spaces shall also have load shedding tested during commissioning.

b. Central Plants

i. Supply Temperature Reset

c. Terminal Units

i. Occupancy Sensors

1. If no motion is detected during a 30 minute (adj.) duration, the setpoint shall index to the unoccupied setpoints
2. Recommend reducing air change rates and not temperature setpoints. Based on space air change rates, it can take a long duration of time to get back to setpoint.

ii. Load Shedding

1. Unless designated as specialty/exempt, all new / modified areas shall require a modification to the load control / load shedding program as directed by Facilities, confirmed by E&C. These spaces shall also have load shedding tested during commissioning.
2. When load shed is enabled, all terminal units listed for load shed shall index to the cooling mode. The Load Shed setpoint and the terminal unit setpoint shall be compared with the Max being set to the terminal unit active cooling setpoint.
3. HIM building will have the heating and cooling setpoints mapped to the terminal unit controllers for existing JCI controls.

iii. VAV boxes

1. CO2 Reset routine
2. Discharge air temperature maximum setpoint shall be 15 DegF above the room temperature setpoint.

iv. Fan Coil Units

1. Fans shall cycle during occupied and unoccupied hours until required based on occupied and unoccupied temperature setpoints. For EC motors they shall be at minimum speed during deadband and modulate when required for heating and cooling.



2. Ceiling hung units shall have liquid high level sensor to close chilled water valve and generate an alarm.
- v. Radiant Panels
1. Recommend not enabling until below 45 DegF outside air temperature for control.
 2. Recommend on/off control based on low btu/ft output.
- d. Smoke Control
- i. Smoke control functions should be initiated by the Fire Alarm System.

 HARVARD MEDICAL SCHOOL	FACILITIES DESIGN STANDARD CONSTRUCTION/RENOVATION	SOP #: HMS_DS_ELECTRICAL_161031_0
TITLE: Division 26 - Electrical		REVISION: October 31, 2016

26 0500 – Existing Building Electrical Systems Description

1. Quad Building

a. Incoming Electrical Service

- i. The incoming primary electric service for the original Quad buildings consists of medium voltage switchgear (Building “E” Terrace Substation) and has 2 incoming medium voltage circuits (13.8 kV); one from MATEP and the other from Eversource. The switchgear is arranged in a main-tie-main configuration and the tie breaker is normally closed. The switchgear is located under the terrace of the original Tosteson Medical Education Center, Formerly Building E.
- ii. Two (2) feeders emanate from each side of the tie breaker in the switchgear; feeders 1 and 2 serve the Harvard Medical School and Harvard Dental School Buildings identified below; feeders 3 and 4 serve the Harvard School of Public Health.

b. The following HMS buildings are served by this switchgear:

- i. Armenise Building
- ii. Building C
- iii. Countway Library
- iv. Goldenson Building
- v. Gordon Hall
- vi. Laboratory for Human Reproduction and Reproductive Biology (LHRRB)
- vii. Research and Education Building (REB)
- viii. Seeley Mudd
- ix. Tosteson Medical Education Center (TMEC)
- x. Vanderbilt
- xi. Warren Alpert

c. In addition, Harvard School of Public Health Buildings 1, 2, 3 and FXB are served by this switchgear.

2. Armenise Building

a. Normal Power

- i. The normal service consists of an unusual double ended arrangement; a single 500 kVA oil filled transformer serves one side of the double ended substation and two (2) 500 kVA oil filled transformers serve the other side. All secondary main breakers are closed, and the tie breaker is closed. All transformers are protected with oil disconnect switches. Dry type transformers and low voltage (208/120 Volt, 3 Phase, 4 Wire) switchboard are located in the Basement.



- b. Stand-By/Emergency Power
 - i. A 460 kW, 208/120 Volt, 3 Phase, 4 Wire natural gas fired generator is located on the roof in a sound attenuated enclosure.
- 3. Building C
 - a. Normal Power
 - i. The normal service consists of an unusual double ended arrangement; a single 500 kVA oil filled transformer serves one side of the double ended substation and two (2) 500 kVA oil filled transformers serve the other side. All secondary main breakers are closed, and the tie breaker is closed. All transformers are protected with oil disconnect switches. Dry type transformers and low voltage (208/120 Volt, 3 Phase, 4 Wire) switchboard are located in the Basement.
 - b. Stand-By/Emergency Power
 - i. A 200 kW, 208/120 Volt, 3 Phase, 4 Wire diesel fired generator is located on the roof in a sound attenuated enclosure.
- 4. Countway Library
 - a. Normal Power
 - i. The normal service consists of one double ended 1,500 kVA substations with primary selective load break switches, dry type transformers and low voltage (480/277 Volt, 3 Phase, 4 Wire) drawout switchgear located in the Basement main electrical room.
 - ii. Stand-By/Emergency Power
 - 1. A 400 kW, 480/277Volt, 3 Phase, 4 Wire diesel fired generator is located on grade in a sound attenuated enclosure.
 - iii. Lightning Protection System
 - 1. A UL Master Label lightning protection system is provided on Countway Library.
- 5. Goldenson Building
 - a. Normal Power
 - i. The normal service consists of a double ended arrangement where two (2) 500 kVA transformers, each with an oil disconnect switch serve one side of the substation, and one (1) 750 kVA transformer serves the other side.



Both main breakers are closed, and the tie is open. System is 208/120 Volt, 3 Phase, 4 Wire. Switchboard is located in the Basement.

ii. Stand-By/Emergency Power

1. A 250 kW, 208/120 Volt, 3 Phase, 4 Wire diesel fired generator is located on grade in a sound attenuated enclosure.

6. Gordon Hall

a. Normal Power

- i. The main normal service for Gordon Hall consists of two 500 kVA transformers each with primary selective load break switches connected in a network arrangement to a common low voltage (208/120 Volt, 3 Phase, 4 Wire) switchboard located in the Basement.
- ii. A second service to Gordon Hall is fed from Countway Library via a 480 volt, step down transformer and serves the Data Center.

b. Stand-By/Emergency Power

- i. The Emergency (Life Safety) system is served form C Building generator, and the Data Center is served by the Countway Library generator.

7. Harvard Institutes of Medicine (HIM)

a. Incoming Electrical Service

- i. Incoming electric service consists of medium voltage switchgear with 2 medium voltage circuits (13.8 kV) from Eversource in a primary selective arrangement, located in the Basement.

b. Normal Power

- i. The normal service consists of a double ended 2,500 kVA substation with primary selective load break switches, dry type transformers and low voltage (480/277 Volt, 3 Phase, 4 Wire) drawout switchgear located in the Basement.

c. Stand-By/Emergency Power

- i. A 1,200 kW, 480/277 Volt, 3 Phase, 4 Wire diesel fired generator is located on the roof in a sound attenuated enclosure.



- d. Lightning Protection System
 - i. A UL Master Label lightning protection system is provided on the Harvard Institutes of Medicine building.
- 8. Laboratory for Human Reproduction and Reproductive Biology (LHRRB)
 - a. Normal Power
 - i. The normal service consists of two double ended oil filled 1,000 kVA substations, each with primary selective load break switches, dry type transformers and low voltage (208/120 Volt, 3 Phase, 4 Wire) switchboard, located in the Basement. Low voltage switchboard was replaced in 2016.
 - b. Stand-By/Emergency Power
 - i. A 400 kW, 208/120 Volt, 3 Phase, 4 Wire diesel fired generator is located on the roof in an enclosure.
- 9. New Research Building (NRB)
 - a. Incoming Electrical Service
 - i. Incoming electric service consists of medium voltage switchgear with 2 medium voltage circuits (13.8 kV) from Eversource in a main-tie-main arrangement, located in the Basement.
 - b. Normal Power
 - i. The normal service consists of two double ended 2,500 kVA substations, each with primary selective load break switches, dry type transformers and low voltage (480/277 Volt, 3 Phase, 4 Wire) drawout switchgear, located in the Basement. Normal power laboratory busways are served from both sides of the double ended substation through a closed transition transfer switch.
 - c. Stand-By/Emergency Power
 - i. Two 1,500 kW, 480/277 Volt, 3 Phase, 4 Wire diesel fired generators are located in the Penthouse Mezzanine and connected to paralleling switchgear.
 - d. Lightning Protection System
 - i. A UL Master Label lightning protection system is provided on the New Research Building.



10. Seeley G. Mudd

a. Normal Power

- i. The normal service consists of two double ended 750 kVA substations, each with primary selective load break switches, dry type transformers and low voltage (208/120 Volt, 3 Phase, 4 Wire) switchboard, located in the Basement.

b. Stand-By/Emergency Power

- i. A 750 kW, 208/120 Volt, 3 Phase, 4 Wire diesel fired generator is located on the roof in an enclosure.

11. Tosteson Medical Education Center (TMEC)

a. Normal Power

- i. The normal service to the original E Building consists of an unusual double ended arrangement; a single 500 kVA oil filled transformer serves one side of the double ended substation and two (2) 500 kVA oil filled transformers serve the other side. All secondary main breakers are closed, and the tie breaker is closed. All transformers are protected with oil disconnect switches. Dry type transformers and low voltage (208/120 Volt, 3 Phase, 4 Wire) switchboard are located in the Basement.
- ii. The normal power service to the TMEC Addition consists of a single ended 1,000 kVA substation with primary selective load break switches, dry type transformer and low voltage (480/277 Volt, 3 Phase, 4 Wire) switchboard located in the Basement.

b. Stand-By/Emergency Power

- i. One 200 kW, 480/277 Volt, 3 Phase, 4 Wire diesel fired generator is located in the Penthouse

12. Vanderbilt Hall

a. Normal Power

- i. The normal power service consists of a single ended 750 kVA substation with primary selective load break switches, dry type transformer and low voltage (208/120 Volt, 3 Phase, 4 Wire) switchboard located in the Basement.



- b. Stand-By/Emergency Power
 - i. One 450 kW, 208/120 Volt, 3 Phase, 4 Wire diesel fired generator is located on an elevated platform, at grade, between Vanderbilt Hall and the Children's Hospital Parking Garage.
 - ii. Vanderbilt Hall is a designated area of rescue/shelter. Additional equipment shall be provided with emergency power as required to meet the needs of the shelter.
13. Warren Alpert Building
- a. Normal Power
 - i. The normal service consists of a double ended 2,000 kVA substation with primary selective load break switches, oil filled transformers and low voltage (480/277 Volt, 3 Phase, 4 Wire) drawout switchgear located in the Basement.
 - ii. In addition, a single ended 3,000 kVA substation, with primary selective load break switches, dry type transformer and low voltage switchboard (480/277 Volt, 3 Phase, 4 Wire) is located on the roof. This substation is served from a separate Eversource line (106-H4) and provides power to the air cooled peak shaving chillers. The Eversource line also serves 180 Longwood pad mounted transformer.
 - b. Stand-By/Emergency Power
 - i. One 1,000 kW, 480/277 Volt, 3 Phase, 4 Wire diesel fired generator is located in the Penthouse
14. 158 Longwood Avenue
- a. Normal Power
 - i. The normal service is fed from a utility company transformer in transformer vault (HW to confirm).
 - b. Emergency Power
 - i. Emergency lighting is powered with individual emergency powered fixtures.
15. 160-164 Longwood Avenue
- a. Normal Power
 - i. Service to the building is 240/120 Volt, single phase, form a 100 kVA transformer



b. Stand-By/Emergency Power

- i. Emergency lighting is powered with individual emergency powered fixtures.

16. 180 Longwood Avenue

a. Normal Power

- i. A 500 kVA pad mounted transformer serves a 208/120 Volt switchboard in the basement. This transformer is served from a separate Eversource line (106-H4) which also serves the peak shaving chiller substation on the Warren Alpert roof.

b. Stand-By/Emergency Power

- i. A 150 kW, 208/120 Volt, 3 Phase, 4 Wire diesel fired generator is located in the basement. Generator was replaced in 2016.

17. 641 Huntington Avenue

a. Normal Power

- i. Service to the building is an 800 amp, 240 Volt delta system with one phase grounded. A 75 kVA step-down transformer provided 208/120 Volt power.

b. Stand-By/Emergency Power

- i. Emergency lighting is powered with individual emergency powered fixtures.

18. School of Dental Medicine

a. Normal Power

- i. The normal service consists of a 500 kVA dry type distribution transformer fed by the Research and Education Building (REB).

b. Stand-By/Emergency Power

- i. A 75 kW, 208/120 Volt, 3 Phase, 4 Wire diesel fired generator is located in the basement.

19. Research and Education Building (REB)

a. Normal Power

- i. The normal service consists of a double ended 1,500 kVA substation with primary selective load break switches, dry type transformers and low voltage (480/277 Volt, 3 Phase, 4 Wire) drawout switchgear located in the Basement.



- b. Stand-By/Emergency Power
 - i. One 650 kW, 480/277 Volt, 3 Phase, 4 Wire diesel fired generator is located in the Penthouse
- c. Lightning Protection System
 - i. A UL Master Label lightning protection system is provided on the Research and Education Building.

26 0510 – Electrical Commissioning

- 1. Electrical Commissioning
 - a. The Design Team shall provide fully integrated design documents to ensure all required Contractors are fully responsible for supporting the Commissioning activities for the proposed systems to be commissioned. All required labor hours and materials shall be included for, at a minimum but not limited to, meetings, supporting documentation, field testing activities, ancillary testing equipment, off-season testing, data storage, support for 10 month warranty verification (if required), etc.
 - b. The Design Team shall work with the project Commissioning Agent to incorporate all of their testing requirements into the contract specifications.
 - c. Lighting Controls
 - i. Specifications shall include requirements to test lighting control components as follows:
 - 1. Occupancy Sensors
 - a. Each occupancy sensor shall be tested to ensure lights turn on and stay on while space is occupied, and turn lights off following 15 minutes of vacancy.
 - b. Each occupancy sensor shall be tested to ensure HVAC systems are properly interfaced with the occupancy sensor to turn on HVAC systems when the room is occupied, and turn off/turn back HVAC systems following 45 minutes of vacancy.
 - 2. Vacancy Sensors
 - a. Each vacancy sensor shall be tested to ensure lights turn on via manual intervention only, stay on while space is occupied, and turn lights off following 15 minutes of vacancy.



- b. Each vacancy sensor shall be tested to ensure HVAC systems are properly interfaced with the occupancy sensor to turn on HVAC systems when the space lighting switch is activated, stay on while the space is occupied, and turn off/turn back HVAC systems following 15 minutes of vacancy.

3. Daylight Harvesting

- a. Daylight harvesting systems shall be tested to ensure lighting levels are reduced to the appropriate level, as determined by the HMS Project Manager, when the maximum amount of daylighting is available in the space.
- b. Daylight harvesting systems shall be tested to ensure lighting levels are brought up to 100% when the amount of daylighting available in the space is insufficient to properly illuminate the space, as determined by the HMS Project Manager.

4. System Programming

- a. All systems that require programming shall be programmed to control devices as indicated in this section. Programming shall also be tested for:
 - i. Astronomic control
 - ii. Daylighting control
 - iii. Time-of-day control
 - iv. Etc.

d. Low Voltage Distribution Equipment (120-600 VAC)

- i. Ensure that all circuit breaker trip settings have been adjusted to the values indicated in the Power System Study performed for the project.
- ii. Perform system function tests upon completion of equipment tests. It is the purpose of system function tests to prove the correct interaction of all sensing, processing, and action devices.

1. Implementation

- a. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
- b. Verify the correct operation of all sensing devices, alarms, and indicating devices.

e. Infrared Scanning



- i. Provide a thermographic survey of all busway and other equipment as requested by the HMS Project Manager one year after the building is turned over to the Owner.
- ii. Visual and Mechanical Inspection
 1. Inspect physical, electrical, and mechanical condition.
 2. Remove all necessary covers prior to thermographic inspection.
- iii. Provide report including the following:
 1. Discrepancies.
 2. Temperature difference between the area of concern and the reference area.
 3. Cause of temperature difference.
 4. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.
 5. Identify load conditions at time of inspection.
 6. Provide photographs and/or thermograms of the deficient area.
- iv. Test Parameters
 1. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.
 2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
 3. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected. Refer to NFPA 70B-1994, Section 18-16 (Infrared Inspection).
- v. Test Results
 1. Temperature differences of 1°C to 3°C indicate possible deficiency and warrant investigation.
 2. Temperature differences of 4°C to 15°C indicate deficiency; repair as time permits.
 3. Temperature differences of 16°C and above indicate major deficiency; repair immediately.]



1. Design Statement

- a. During the various design phases of this project, the Engineer will develop options and schemes for selection of the appropriate electrical system. This approach will enable the entire Design Team (Owner, Architect and Engineer) to partake in the decision making process concerning the selection of the electrical system and major equipment.
- b. Discuss the following system characteristics with the Project Manager, and incorporate each into the design as required for the project:
 - i. Flexibility for future changes.
 - ii. Durability; ease of maintenance.
 - iii. Reliability
 - iv. Future expansion
 - v. Cost effectiveness
- c. Every effort will be made to design, layout and install equipment in locations which will tend to encourage routine preventive maintenance by providing easy access for maintenance personnel.

2. Codes, Standards and References

- a. The electrical systems will be designed to comply with the latest volume or publication of following codes and standards:
 - i. Massachusetts State Building Code
 - ii. Massachusetts Electrical Code
 - iii. National Fire Protection Association (NFPA)
 1. NFPA 70 National Electrical Code
 2. NFPA 72 National Fire Alarm Code
 3. NFPA 101 Life Safety Code
 - iv. NFPA 110 Emergency and Standby Power Systems
 - v. Underwriters Laboratories (UL)
 - vi. Factory Mutual (FM)



- vii. Occupational Safety and Health Administration (OSHA)
- viii. Environmental Protection Agency (EPA)
- ix. Massachusetts Department of Environmental Protection (DEP)
- x. American National Standards Institute (ANSI)
- xi. American Society of Testing Materials (ASTM)
- xii. American Wire Gauge (AWG)
- xiii. National Electrical Manufacturers Association (NEMA)
- xiv. Institute of Electrical and Electronic Engineers (IEEE)
- xv. National Electrical Testing Association (NETA)

3. Utilization Voltages

- a. Receptacles: 120V, 1-phase.
- b. Fluorescent Lighting: 277V, 1-phase, if available, otherwise, 120V, 1-phase.
- c. LED Lighting 277V, 1-phase, if available, otherwise, 120V, 1-phase.
- d. Incandescent Lighting: 120V, 1-phase.
- e. Motors 1/3 HP and smaller: 120V, 1-phase.
- f. Motors 1/2 HP and larger: 480V, 3-phase, if available, otherwise, 208V, 3-phase..

4. Normal Power

- a. The electrical system loads will be designed as follows:
 - i. 0.1 to 1.0 volt-amperes (VA)/sq.ft. for lighting or as allowed by the Energy Code.
 - ii. 3.0 VA/sq.ft. for power-Office Areas.
 - iii. 10 VA/sf for laboratory power
 - iv. 2.0 VA/sq.ft. for power-All Other Areas
 - v. 8.0 to 10.0 VA/sq.ft. for Plumbing and HVAC air handling equipment or as required by the project.

5. Stand-by Power



- a. The emergency and legally required stand-by electrical system will be designed as follows:
 - i. 0.25 VA/sq.ft. for emergency life safety lighting
 - ii. 0.25 VA/sq.ft. for miscellaneous life safety power including fire alarm system, plumbing equipment, etc.
- b. The optional stand-by electrical system will be designed as follows:
 - i. 0.25 VA/sq.ft. for lighting in selected areas.
 - ii. 5.0 to 7.5 VA/q. Ft. For selected laboratory optional standby power
 - iii. 2.5 VA/sq.ft. for minimal fume hood exhaust system, if required by the Project.
 - iv. The following systems shall be provided with optional standby power as required for the project:
 - 1. Central building/laboratory equipment, including domestic water booster pumps, minimal laboratory exhaust systems, etc.
 - 2. Animal facility power.
 - 3. Animal facility air handling systems.

6. Lighting

- a. All lighting levels will conform with the Illuminating Engineering Society's recommendations and, in general, average maintained lighting levels shall be as follows:
 - i. Laboratories – general illumination: 40 to 50 FC
 - ii. Laboratories – task illumination 100 FC
 - iii. Laboratory support: 30 to 40 FC
 - iv. Offices: 30 to 40 FC
 - v. Working Corridors: 20 to 30 FC
 - vi. Conference Rooms/Classrooms : 40 to 50 FC
 - vii. Toilets: 20 to 30 FC
 - viii. Lobbies and Foyers: 20 to 30 FC
 - ix. Animal Holding Rooms (Day/Night Cycle): discuss with User
 - x. Animal Holding Rooms (Working): discuss with User
 - xi. Utility and MEP/FP/IT Equipment Rooms: 30 to 50 FC
 - xii. Utility Corridors: 5 to 15 FC

7. Receptacles

- a. Normal Power



- i. Laboratories
 - 1. Two (2) circuit surface mounted raceway at laboratory bench with duplex receptacles on 18" centers.
 - ii. Laboratory Support
 - 1. Two (2) circuit surface mounted raceway along equipment wall with duplex receptacles on 24" centers.
 - 2. Wall mounted special purpose, 208V receptacles for larger equipment 5'-0" on center.
 - iii. Offices
 - 1. One (1) duplex receptacle per wall and (1) double duplex receptacle at desk location.
 - iv. Animal Holding Rooms
 - 1. One (1) duplex receptacles per animal holding room mounted 48" AFF. with ground fault protection and weatherproof cover plate.
- b. Optional Stand-By Power
- i. Laboratories
 - 1. One (1) duplex receptacle at each laboratory bench (mounted on utility column).
 - ii. Laboratory Support
 - 1. Selected receptacles and equipment at equipment areas, including selected special purpose receptacles.
 - 2. Provide a minimum of 25% normal power receptacles in areas with high concentration of Optional Stand-by power.
 - iii. Animal Holding Rooms
 - 1. Duplex receptacles mounted 48" AFF. with ground fault protection and weatherproof cover plate.
- c. Plug Load Control
- i. Provide plug load control via room lighting motion sensor if required by ASHRAE 90.1 Energy Code.



8. Circuiting Criteria

a. General Lighting

- i. 277 volt lighting shall be limited to 3200 VA per 20A, 1 pole circuit.
- ii. 120V lighting shall be limited to 1200 VA per 20A, 1-pole circuit.
- iii. All dimmer switches shall be rated for 2000 VA minimum.

b. Receptacles

- i. All laboratory receptacle circuits shall have a maximum of (4) duplex outlets on a 20A, 1-pole circuit, 120V.
- ii. Convenience receptacle circuits shall have a maximum of (6) duplex outlets on a 20A, 1-pole circuit, 120V.
- iii. All duplex and special purpose receptacles indicated for specific equipment shall be on a separate dedicated circuit.

c. Motors

- i. All motors 1/8 HP and under shall be wired not more than (3) per 20A, 1-pole circuit, 120V.
- ii. All motors above 1/8 HP shall have individual circuit breakers.
- iii. All motors 1/2 HP and above shall be 3-phase and on individual circuits, 480V, if available, otherwise 208V.
- iv. Motors shall have efficiency levels of ASHRAE 90.1 or IECC Energy Codes.

9. Grounding

- a. A complete equipment grounding system shall be provided such that all metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, metal fences, and all other conductive items operate continuously at ground potential and provide a low impedance path to ground for possible fault currents.
- b. The main equipment electric room shall be provided with continuous copper ground bus around the perimeter of the room for properly bonding and grounding all main switchgear. The ground bus shall be bonded to the exterior ground grid system and ground rods.



- c. A grounding network for the main service equipment and lightning protection system shall be provided consisting of a buried ground loop around the perimeter of the building, bonding to building steel, copper ground rods, etc.
- d. A separate insulated green grounding conductor shall be provided for each single and 3-phase feeder and branch circuit. Grounding conductor shall be run with the related phase and neutral conductors. Panel feeders installed in more than (1) raceway shall have individual, full sized, green grounding conductor in each raceway. The equipment grounding system shall not rely on the metallic raceways for grounding continuity.
 - i. A separate, isolated ground system riser shall be provided originating at the main building service grounding point. Ground busses shall be provided on each floor for systems and equipment requiring isolated ground.

26 0530 – Wiring and Wiring Devices

1. Medium Voltage Conductors

- a. The medium voltage cable shall be single conductor, ethylene-propylene rubber (EPR) insulated, shielded and jacketed power cable for medium voltage applications, and shall be in accordance with NEC Article 328. Cables shall be UL listed and designated as MV-105. Cable shall be able to withstand a fault at the magnitude indicated in the short circuit study for at least 5 seconds.

2. 600 Volt Conductors

- a. Wire and cable for feeders, lighting, power, branch circuits and control circuits for systems operating between 50 and 600 volts shall be soft drawn, 98% conductive copper with 600 volt rated insulation.
- b. The phase, neutral and ground conductors for all feeder, branch circuit and auxiliary system wiring passing through pull boxes and/or being made up in panelboards shall be properly grouped, bound and tied together in a neat and orderly manner in keeping with the highest standards of the Trade, with plastic cable ties in at least one location within the enclosure. Loose ends of the cable ties shall be properly trimmed after making up same. Cable ties shall be Ty-Raps, as manufactured by Thomas & Betts, Holub Industries, Inc., Quick-Wrap, Burndy Unirap or equal.
- c. Color coding of conductors shall match the Owners color coding standard. If no standard color coding system exists, use the following:

208/120 Volts			480/277 Volts		
A Phase	-	Black	A Phase	-	Brown
B Phase	-	Red	B Phase	-	Orange
C Phase	-	Blue	C Phase	-	Yellow



208/120 Volts		480/277 Volts	
Neutral Phase A	- White w/ Black Stripe	Neutral Phase A	- Grey w/ Brown Stripe
Neutral Phase B	White w/ Red Stripe	Neutral Phase B	Grey w/ Orange Stripe
Neutral Phase C	White w/ Blue Stripe	Neutral Phase C	Grey w/ Yellow Stripe
Ground	- Green	Ground	- Green w/ Yellow Stripe
Isolated Ground	- Green w/ Orange Stripe		

- d. Color coding shall be continuous on insulation for all conductors. For conductors larger than #6 where continuous color coding is not available, each conductor shall be marked with color tape at all connections and in all pull, junction and outlet boxes.
- e. For large size conductors available only in black, use colored plastic tape at all ends, where connections and splices are made and in all pull boxes for the specified color code identification. Tape shall be wrapped around the conductor (3) complete turns.
- f. For 120 volt and 277 volt single phase circuits, Electrical Subcontractor shall provide additional identification to identify each neutral conductor with its associated phase conductor in all pull, junction and outlet boxes.

3. Branch Circuits

- a. Branch circuit conductors shall be single-conductors 600V rated with THWN or THHN insulation with continuous color coding.
- b. Branch circuit conductor shall be a minimum #12 AWG. Each branch circuit shall include a dedicated neutral conductor. No more than 7 conductors (3-phase, 3 neutral and 1 ground) shall be installed in a common conduit.
- c. Metal Clad Cable
 - i. The use of metal clad cable, and hospital grade metal clad cable, with redundant ground, shall be discussed with the Project Manager
 - ii. MC cable, with insulated green ground conductor **[and redundant ground]**, may be utilized in lieu of conduit and cable in dry, hollow partitions and accessible ceiling cavities for general purpose, 20 ampere, single phase, 120 or 277 volt, branch circuits for receptacles and lighting fixtures only.
 - iii. For lighting fixture whips; maximum length 6', maximum 4 fixtures connected to a common junction box.
 - iv. For 20 ampere, single phase, 120 volt receptacle circuits; maximum length from junction box to first receptacle 30'. Maximum length between receptacles 15'. Maximum 4 receptacles connected together.



- v. For branch circuit homeruns to surface mounted panels, MC cable shall terminate in a junction box 5'-0" (minimum) horizontally away from the panel and conduit shall be run to the panel. If panelboards are located in rooms designated as electric rooms or closets, MC cable shall terminate in a junction box outside of the electric room and conduit shall be run to the panel.
 - vi. Uses Not Permitted
 - 1. MC cable shall not be allowed in electric rooms or closets.
 - 2. MC cable shall not be used in mechanical or plumbing rooms, closets or shafts, including mechanical penthouse.
 - 3. Branch circuits larger than 30 ampere.
4. Raceways
- a. Raceways for feeders and branch circuits shall be metallic, rigid metal conduit, intermediate metal conduit (IMC) or electrical metallic tubing (EMT) subject to the restrictions of the National Electrical Code, minimum size 3/4". EMT shall not be used in concrete construction or where subjected to mechanical damage.
 - b. Exterior ductbanks shall be comprised of PVC Schedule 40 conduit encased in concrete. Concrete duct banks shall be formed of plywood. Where ductbanks penetrate foundation walls or manholes, rigid galvanized steel (RGS) conduit shall be used.
 - c. Raceways shall not be allowed in concrete floor slabs.
 - d. Conduit shall be run concealed in finished areas above suspended ceilings, in wall spaces, etc. All conduit runs shall be properly grouped and installed parallel to walls, ceilings, etc., and supported with proper hangers, clamps, etc. Door swings shall be checked before installing back boxes for switches and receptacles.
 - e. raceways in finished areas shall be Wiremold raceway with HMS project Manager and Architect's approval.
 - f. Conduit bends shall be made with conduit bending machines or by an approved hickey. Lock nuts and insulated throat bushings of the compatible material shall be used to fasten conduit to outlet boxes, cabinets, etc.
 - g. Separation of Wiring:
 - i. Raceways for the emergency branch, legally required and optional stand-by branch of the emergency electrical system shall be kept entirely independent of all other raceways and shall not enter the same raceways, boxes or cabinets with each other or other wiring, except in transfer switches.

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- ii. Where a branch of the emergency system contains multiple transfer switches, raceways downstream from the two (or more) transfer switched shall be kept independent of each other.

h. Cable Management

- i. Cable tray shall be provided in IT closets, Utility Tunnels and as directed by the HMS Project Manager.

5. Wiring Devices

- a. All wiring devices shall be the product of a single manufacturer, except where specifically stated otherwise.
- b. All devices shall be standard or “Decora” style and shall be consistent with the adjacent areas.
- c. Devices with ground fault circuit interrupter shall be feed thru type and include an indicator light that illuminates when the device is tripped and a self-test feature that conducts an automatic test a minimum of every sixty (60) seconds to ensure ground fault protection is functioning. If ground fault protection is compromised, power to the receptacle shall be discontinued and an indicator light shall flash indicating that the unit should be replaced.
- d. All devices in bathrooms/toilets, within 6’-0” of sink locations, exterior outlets, utility vault, in wet areas, etc. shall be ground fault type.
- e. The equipment grounding contacts for isolated ground devices shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
- f. Surge protective devices shall be provided for A/V equipment including televisions, amplifiers, etc. and include:
 - i. Integral line to ground, line to neutral, and neutral to ground surge protection. Surge protection components shall include multiple metal-oxide varistors with a nominal clamp-level rating of 500 volts and minimum single transient pulse energy dissipation of 300 joules, according to IEEE C62.41.2 and IEEE C62.45.
 - ii. Device shall include an active visual and audible indication, with light visible in face of the device to indicate the device is "active" or "no longer in service". Green light = protected; flashing red light = no longer protected; no light = no power to unit.



- g. USB charging receptacles shall be provided in classroom spaces and include an LED indicator to show USB power available, and shall be compatible with 1.x, 2.0 and 3.0 devices, including Apple products.
- h. Color of all devices shall be white, unless directed otherwise by the Project Manager or Architect.
- i. Devices on the Emergency system shall be red.
- j. Devices on the Optional Standby system shall be red
- k. All normal power wiring device plates shall be stainless steel with a brushed finish, type 302/304: All normal power wiring device plates shall be high impact nylon/thermoplastic:
- l. All Emergency branch power wiring device plates shall be stainless steel with a brushed finish, type 302/304 with red filled "EMERGENCY" engraved in plate:
- m. All Optional Stand-By branch power wiring device plates shall be stainless steel with a brushed finish, type 302/304 with red filled "Stand-By" engraved in plate: {Engraved or P Touch Labels??}
- n. Heads of device plate screws shall be of the same material/color as the device plate.

6. Outlet Boxes

- a. Outlet boxes, for wiring devices in new hollow frame partitions shall be mounted on "stud-to-stud" type mounting brackets. Brackets shall be secured using self-threading metal screws, and shall engage more than one stud for support.
- b. Outlet boxes in existing hollow frame partitions shall be old work type boxes, with tabs. "Madison" bars will not be acceptable

26 0550 – Identification

1. Equipment Identification

- a. Uniquely engraved nameplates, mounted on the face of each assembly, shall be furnished for all electrical distribution equipment specified herein.
- b. Nameplates shall be laminated plastic and secured with screws.
- c. Nameplates shall be a minimum of 2 inch high x 2 1/2 inch wide, laminated with **[black letters on white background] [white letters on black background]**.
- d. Characters shall be 3/16 inch high, minimum.



- e. New equipment shall have identification consistent with the building it is installed.
2. Wiring Device Identification
 - a. P Touch labels shall be provided on each wiring device cover indicating panel and circuit number. A legible handwritten tag shall also be provided in the wiring device box.
 3. Conductor Identification
 - a. All conductors shall have panel and circuit number identified in all accessible locations, such as panel troughs, pull, junction and outlet boxes.
 - b. Identification shall consist of plastic nameplates ty-wrapped to the conductors (phase, neutral and ground conductors comprising the circuit), with legible handwritten characters, using a permanent marker.

26 0570 – Power System Studies

1. The Engineers shall perform the following preliminary Power System Studies.
 - a. Short Circuit Studies
 - b. Protective Device Coordination Studies
 - c. Arc Flash Hazard Analysis
2. The studies shall include all portions of the electrical distribution system from the normal power incoming source or sources of power, the emergency standby source or sources, down to and including all panels and distribution equipment in the distribution system. Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.
3. In addition, the study shall include all existing distribution equipment directly affected by the new work. The Engineer shall obtain/verify existing characteristics, feeder sizes, nameplate data, etc. as may be required to complete the studies.
4. The power system studies shall include all new and directly affected existing electrical system components to confirm the adequacy of the interrupting ratings, proper coordination settings of all overcurrent protection devices and to determine the requirements for arc flash protection boundary and incident energy exposure labeling to the satisfaction of the Electrical Engineer.



5. Project specifications shall require the distribution equipment manufacturer or a firm engaged by the distribution equipment manufacturer to perform the final Power System Studies, determine adjustable trip settings and calculate and print Arc Flash labels.
6. Short Circuit Study
 - a. Short circuit study shall include the results for each mode of operation, as follows:
 - i. Normal power available and all transfer switches in the normal position.
 - ii. Emergency generator(s) or emergency source(s) running and all transfer switches in the emergency position
 - iii. If closed transition paralleling is provided, study shall be run for each mode of parallel operation as follows:
 1. Multiple normal sources in parallel
 2. The normal and emergency source in parallel
 3. multiple emergency sources in parallel
 - b. Motor Contribution
 - i. Include fault contribution of all motors in the study as follows:
 1. 100% of all motors with standard starters (no VFD's)
 2. 25% of all motors provided with VFD's and bypass starters
 3. 0% of motors provided with VFD's without bypass starters
 - ii. Motor short circuit contribution shall be included at the appropriate locations in the system as indicated on the drawings, so that the computer calculated values represent the theoretical short circuit current available.
7. Coordination Study
 - a. In the protective device coordination study, provide time-current plots graphically indicating the coordination proposed for the system, centered on conventional, full-size, log-log forms.
8. Arc Flash Study
 - a. Calculation of incident energy exposures shall be performed on all parts of the electrical system, for the Owner's determination and implementation of details of personal

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protective equipment as required by NFPA 70E Standard for Electrical Safety Requirements for Employee Workplaces.

9. The final study shall be completed by the successful switchgear manufacturer.
10. The input data shall be transferred to the HMS Project Manager in a format compatible to the HMS Power System Study software.

26 0580 – Electrical Acceptance Testing

1. All high voltage equipment, cable and transformers shall be high pot tested per NETA standards.
2. All low voltage 600V equipment, cable, motors, dry type transformers, etc., shall be field tested per NETA Standards.

26 0900 – Power Meters

1. Provide full function electronic meters on the following equipment:
 - a. All main circuit breakers.
 - b. All Distribution Panels, either at the panel, or the circuit breaker serving the panel.
 - c. All automatic transfer switches.
2. The meter shall be UL recognized, CSA certified and also meet ANSI Standard C37.90.
3. The meter shall provide direct reading metered or calculated values of the items listed below and shall auto range between Units, Kilo-units, and Mega-units for all metered values. Accuracy indicated below to be of read or calculated values.
 - a. AC Current (Amperes) in A, B, and C phase, 3 Phase Average and Neutral (N). Accuracy +/- 0.2% (provide phase and neutral current transformer).
 - b. AC Voltage (Volts) for A-B, B-C, and C-A, Phase Average, A-N, B-N, and C-N and Average Phase to N. Accuracy +/-0.2%.
 - c. Real Power (WATTS), Reactive Power (VARs), Apparent Power (VA), for each phase and system (system shall apply only for 3 wire applications). Accuracy +/- 0.4%. Forward/Reverse indication shall be provided.
 - d. Real Energy (WHR), Reactive Energy (VARHR), Apparent Energy (VAHR) for each phase and system (system shall apply only for 3 wire applications). Accuracy +/- 0.4%. Forward/Reverse indication shall be provided.



- e. Frequency (HERTZ) Accuracy +/- 0.04%.
 - f. Demand values for System Current (AMPERES), System Real Power (WATTS), System Reactive Power (VARS), and System Apparent Power (VA).
 - g. Power Factor both Displacement only 60 cycle fundamental WATTS to VA and Apparent total WATTS to total VARS including harmonics for A, B, and C phase and system. Accuracy +/- 0.4%.
4. Meters shall have a trending interval of 15 minutes and shall store a minimum of 3 years of data within the meter. Should the meter lose power, data shall be retained in the meter for a minimum of one year.
 5. Meter shall be BacNet (primary), Modbus and TCPIP capable and shall interface with HMS Building Automation System.
 6. Discuss with Project Manager for metering laboratory panel branch circuits.

26 1100 – Medium Voltage Distribution Equipment

1. Medium Voltage Distribution Equipment
 - a. Medium voltage switchgear assemblies shall consist of individual vertical sections having vacuum circuit breakers, customer metering equipment, auxiliary devices and equipment, etc. The switchgear assembly shall meet Eversource and/or MATEP standards.
 - b. The switchgear shall be designed with (2) incoming main circuit breakers with a normally open tie circuit breaker. Each main shall have station class arrestors. The switchgear shall include an automatic transfer scheme including sensing devices and logic equipment such that, upon loss of voltage to the line side of a main that main shall open and then the tie shall close. The automatic transfer scheme shall also include manual-automatic selector switch, logic controller, lockout relays, automatic return to normal condition allowing momentary closed transition, time delays etc. The switchgear shall also contain (4) feeder breakers, (1) per substation transformer and provisions for future expansion. The bus bars shall be copper with 15 kV Class insulation. All bus joints shall be plated, bolted and insulated. The bus shall be braced to withstand fault currents equal to the close and latch rating of the breakers. A copper ground bus shall extend the entire length of the switchgear.
 - c. The 15 kV service shall be distributed in a primary-selective radial system. So that, if one primary feeder is out of service, the remaining feeder has sufficient capacity to carry the total load.
2. Transformers

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- a. Transformers shall be dry type, 13.8 kV to 277/480V, with Class H insulation suitable for 115°C rise.

3. Substations

- a. The primary side of substations shall include medium voltage circuit breakers interconnected with current transformers on the secondary side main circuit breaker, to reduce arc flash incident energy between the transformer secondary terminals and the secondary main circuit breaker.

26 2000 – Low Voltage Distribution Equipment

1. Busway

- a. Vertical busways shall be non-ventilated and supported with adjustable vertical hangers at each floor. The busway shall include phase and neutral copper bus bars with a housing ground. On designated floors busway shall be plug-in type. Maximum capacity of busway shall be 1600A. Busway shall be braced to withstand available short circuit currents. All bus shall be copper.
- b. Busway plug-in circuit breakers for the normal system shall be current limiting type with integral ground fault protection.

2. Circuit Breakers

- a. The following circuit breakers shall contain an energy reducing maintenance switch or an equivalent means of reducing arc flash energy:
 - i. Circuit breakers with no instantaneous trip function or breakers with an instantaneous trip set to a value intentionally set to “0” or “off”.
 - ii. All circuit breakers 1,200 amp frame and above, regardless of trip setting.
 - iii. All circuit breakers with adjustable trip unit if the highest continuous current trip setting can be set to 1,200 amps or above.
- b. Molded case circuit breakers 100 amperes and above shall be molded case and shall provide circuit overcurrent protection with inverse time and instantaneous tripping characteristics. Circuit breakers shall be bolt-on operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy, and arc extinction shall be accomplished by means of arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.



- c. Molded case circuit breakers over 250 ampere frame, shall have be microprocessor-based with true RMS sensing trip units.
 - d. Circuit breakers shall be thermal magnetic type with common type handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100 ampere frame and through 100 ampere trip sizes shall take up the same pole spacing. 20 ampere, single pole circuit breakers shall be UL listed as type SWD for lighting circuits.
 - i. Where ground fault protection is provided or required on building main circuit breaker, downstream feeder breakers shall be provided with ground fault protection and be coordinated with the upstream device.
 - ii. Where ground fault protection is provided on circuit breakers serving busway, and the busway includes a neutral conductor and serves 277 volt loads, such as lighting loads, all feeder circuit breakers on the busway shall be provided with ground fault protection and be coordinated with the upstream device.
3. Switchgear
- a. The switchgear shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide ventilators located on the top of the switchgear over the breaker and bus compartments to ensure adequate ventilation within the enclosure. Hinged rear doors, complete with 3 point latch and provisions for padlocking, shall be provided.
 - b. Each vertical steel unit forming part of the switchgear line-up shall be a self-contained housing having one or more individual breaker or instrument compartments, a centralized bus compartment and a rear cabling compartment. Each individual circuit breaker compartment, or cell, shall be segregated from adjacent compartments and sections, including the bus compartment, by means of barriers. It shall be equipped with draw-out rails and primary and secondary disconnecting contacts. Removable hinge pins shall be provided on the breaker compartment door hinges. Current transformers for feeder instrumentation shall be located within the appropriate breaker cells.
4. Switchboards
- a. Switchboards shall be deadfront, completely metal enclosed, self-supporting structures. All bus bars shall be copper with bolted connections at joints and dedicated ground bus. Switchboards shall be front accessible with panel mounted molded case circuit breakers with solid-state trip units. All trims shall be door-in-door type. All bus shall be copper.
5. Distribution and Branch Circuit Panelboards
- a. Distribution, lighting, receptacle, laboratory and laboratory support panelboards shall be deadfront construction utilizing thermal magnetic circuit breakers. Panels 225A and

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below may be series rated, for the available short circuit current, with the upstream device. Panels over 225A shall be fully rated for the available short circuit current. All trims shall be door-in-door type. All bus shall be copper.

- b. Distribution panels on laboratory floors and all laboratory and laboratory support panels, fed by "K" factor transformers, shall have 200% rated neutral busses.
- c. Each distribution panel and branch circuit panel shall include a wiring trough above. The trough shall be the width and depth of the panel, and shall include a removable cover. The trough shall be mounted directly above the panel with sufficient number of 2" nipples (2 minimum), or may be mounted at a higher elevation (such as above an accessible ceiling) with sufficient number of 2" conduits (2 minimum) connecting it to the panel. All unused circuit breakers have appropriately sized phase, neutral and ground conductors wired from the breaker to the trough. Wiring associated with each breaker shall be properly grouped, supported and labeled in the trough.

6. Step Down Transformers

- a. Step down transformers, 480V delta to to 208/120V, 3-phase wye, shall be dry-type, 2-winding, self-cooled. All bus shall be copper. Transformers provided on laboratory floors shall be suitable for non-sinusoidal current loads with "K" factor not less than 4.
- b. Floor mounted transformers shall be mounted a minimum of 6" from walls with proper clearance in front. Floor mounted transformers shall be installed on non-metallic, vibration isolating pads meeting seismic requirements and selected for at least 0.2" deflection. Panelboards shall not be mounted on wall above transformers.
- c. Trapeze mounted transformers shall be supported with threaded rods and channel and shall be isolated with hanger isolators meeting seismic requirements and suitable for the weight and size of the transformer.

7. Concrete Housekeeping Pads

- a. Concrete pads shall be installed for all freestanding electrical distribution equipment.
- b. All concrete housekeeping pads shall extend beyond the equipment supported as follows:
 - i. Equipment with front and rear access, or equipment mounted freestanding with access in front and rear:
 1. 1" in front of the equipment
 2. 6" on each side of the equipment
 3. 6" in back of the equipment
 - ii. Equipment with front access only, mounted against a wall:



1. 1" in front of the equipment
 2. 6" on each side of the equipment
 3. 0" in back of the equipment
- c. If overcurrent devices exceed 6'-6" above finished floor as a result of the housekeeping pad, the pad shall extend in front of the gear a minimum of 4'-0", and include ramps on each end.

26 3000 – Stand-by Power

1. The following equipment is proposed to be provided with stand-by power in the event of a normal power failure.
 - a. Emergency Systems Power
 - i. Egress lighting
 - ii. Exit signs
 - iii. Fire alarm equipment
 - iv. One elevator per elevator bank
 - v. Fire pump/jockey pump
 - b. Legally Required Stand-by System Power
 - i. Sewage ejectors
 - ii. One elevator per elevator bank
 - iii. Minimal fume hood exhaust system
 - iv. Building automation system and accessories
 - v. Emergency Generator room lighting and receptacles
 - c. Optional Stand-by System Power
 - i. One (1) receptacle per 5'-0" of equipment wall space in laboratory support areas
 - ii. Miscellaneous special purpose (208 volt) receptacles in laboratory support areas.
 - iii. Miscellaneous central laboratory equipment (i.e., purified water system, etc.)
 - iv. Environmental rooms
 - v. -80 degrees C and lower freezers (if generator capacity allows)
 - vi. Minimal fume hood exhaust system



- vii. Laboratory waste system
- viii. Radioactive hood exhaust fans
- ix. BSL-3 suites
- x. Building heating systems to protect building from freezing
- xi. Animal facility heating system
- xii. Animal facility air handling equipment
- xiii. Selected building supply and exhaust systems
- xiv. Additional lighting in selected areas (Vivarium)
- xv. Sump pumps
- xvi. Water booster pumps
- xvii. Hot water circulating pumps
- xviii. Security system
- xix. Telecommunication system

2. Stand-By Generators

- a. Diesel fired engine-generator sets shall be provided to supply electrical power to building emergency, legally required and optional stand-by (essential laboratory, vivarium and building power equipment) systems in the event of loss of normal power.
- b. Generators shall be 480/277 volt, 3-phase, 4-wire, 60 Hz, 12 lead, 0.8 power factor. The generators shall be a permanent magnet generator (PMG) with brushless construction using full wave 3-phase rotating rectifier assembly.
- c. Each unit shall be capable of picking up its rated capacity in one step and provide a transition time for the emergency system loads of (10) seconds or less from instant failure of the normal power source to the stand-by generator source. Legally required and optional stand-by loads shall transfer within (15) seconds from failure of the normal power source.
- d. Generator "run" signal shall connect to the HMS Building Automation System.

3. Automatic Transfer Switches

- a. Each automatic transfer switch shall be provided with a bypass isolation switch. The bypass isolation switch shall provide a safe and convenient means for manually bypassing and isolating the automatic transfer switch regardless of the condition or position of the switch. Each automatic transfer switch shall be double-throw, actuated by (2) electric operators. Each transfer switch shall have an inherent "off" position for shedding the load in the event of an engine-generator failure.
- b. Closed transition automatic transfer switches shall be used for critical loads, as determined by the Project Manager.

4. Emergency System Wiring



- a. The following emergency branch and legally required branch feeders, branch circuits and control circuits shall be 2 hour fire rated type MI mineral-insulated metal-sheathed cable where not installed in spaces fully installed within a 2 hour fire rated room, closet and/or shaft:
 - i. Feeders from the generator(s) to main emergency distribution equipment.
 - ii. Feeder from the generator or generator distribution system to the fire pump controller.
 - iii. Feeders from main emergency distribution equipment to each emergency branch and legally required branch automatic transfer switch.
 - iv. Feeders from each emergency branch and legally required branch automatic transfer switch to associated distribution equipment.
 - v. Feeders from emergency branch and legally required branch distribution equipment to all downstream switchboards panelboards, transformers, enclosed circuit breakers, etc.
 - vi. Feeder from the main normal distribution system to the fire pump controller.
 - vii. Branch circuit wiring to all smoke evacuation, stairwell pressurization, elevator pressurization fans, and associated equipment.
 - viii. Branch circuit to elevator motor(s), controller(s) and cab lighting.
 - ix. Engine start circuit from each automatic transfer switch to the generator.
5. Load Bank
 - a. Discuss with the Project Manager the need for a radiator mounted load bank, sized for a minimum of 30% of the full power rating of each generator.
6. Docking Station
 - a. Furnish an emergency generator docking station at the loading dock of the building, or other similar location, accessible by truck. Docking station shall include the provisions necessary to connect a temporary generator during times when the main generator will be out of service for maintenance, repair or replacement. Docking station shall support a temporary generator of the same rating as the building generator.
 - b. Docking station shall include the capability of connecting a load bank to the generator for testing purposes.
7. Weatherproof housing
 - a. If exterior, the generator set shall be enclosed in a weatherproof, sound attenuated enclosure constructed of aluminum throughout. The housing shall be designed to accommodate heavy snow loads and shall be equipped with motorized intake and



exhaust louvers, pre-wired and pre-piped prior to shipment. Housing shall be constructed per BOCA requirements. Fire suppression shall be provided in walk-in enclosures.

8. Installation

- a. All emergency, legally required and optional standby system equipment, including the generator(s) shall be mounted above the floodplain, as determined by FEMA.

26 5000 – Lighting Fixtures and Controls

1. Lighting Fixtures

- a. Lighting fixtures shall conform to the highest commercial Standards available. Fixture components shall be manufactured of materials most appropriate to their use or function, and resistant to corrosion and to thermal and mechanical stresses encountered in the normal application and function of the fixtures.
- b. Provide recessed fixtures that are constructed to be suitable for, and compatible with, the ceiling, wall or pavement materials and construction in which they shall be installed.
- c. Each and every lighting fixture driver or ballast shall be complete with accessible, individual fuse holder such as Bussman NLR fuse holder or approved equal.
- d. Lighting fixtures shall be UL Listed and Labeled and DesignLights Consortium® (DLC) Listed
- e. Lay-in recessed fixtures in grid type ceilings shall be supported from the underside of roof or floor slab, and utilize hangers with attachments to building construction, independent of other systems. All fixtures shall have a minimum of (2) hangers supports. Hanger wire will not be acceptable.
- f. All lighting fixtures shall be supported from the slab above and shall not be suspended from ducts, piping, equipment, ceiling support system, etc.
- g. Where continuous rows of lighting fixtures are installed (pendant mounted), appropriate mounting channels shall be provided to properly align fixtures.

2. Lamps

- a. Incandescent lamps and Fluorescent lamps will not be acceptable.
- b. Lighting fixtures shall primarily utilize Light Emitting Diode (LED) lamps and drivers.



- c. LED diode arrays shall conform to the following:
 - i. Color temperature of 4,000° Kelvin and minimum Color Rendition Index (CRI) of 82, unless noted by the HMS Project Manager for special circumstances, such as rooms with A/V equipment.
 - ii. Lamp life \geq 50,000 hours, and maintain \geq 70% of initial lamp lumen output throughout this period.
 - iii. Have a minimum efficacy of 50 lumens per watt.
 - iv. LED arrays shall meet all applicable IESNA and ANSI standards relating to measurement and construction in effect at their time of purchase.
 - v. All LED assemblies shall be covered by a (5) year full manufacturer's warranty covering the assembly and its replacement in case of failure, provided that operating conditions (thermal and electrical) are maintained within the manufacturer's stated limits.
- d. Fluorescent Lamps
 - i. Existing fluorescent fixtures in areas of renovation shall be replaced with LED.

3. LED Drivers

- a. Drivers for LED lamps shall be suitable for the electrical characteristics of the supply circuits to which they are to be connected, and which are suitable for operating the specified lamps. Drivers shall have the following characteristics:
 - i. Constant Current/Voltage.
 - ii. Power factor \geq .90
 - iii. Total harmonic distortion \leq 20%
 - iv. Lamp current crest factor \leq 1.7
 - v. UL Class 2
 - vi. Sound Rating A
- b. Where required by the program, or the Project Manager, LED drivers shall be dimmable with 0-10 volt control.
- c. Drivers shall conform to UL, and ANSI specifications and display labels or symbols of approval by UL, and of certification by the CBM. Mark drivers "Class 2" indicating approved integral driver protection. This driver protection is provided by a built-in self-resetting thermally actuated device that will remove the driver from the line when excessive driver temperature is reached.
- d. Rigidly mount drivers, unless specifically indicated otherwise, to the inside of the top of the fixture housing, with driver surfaces and housing in complete contact for efficient



conduction of driver heat. Permanently affix driver mounting screws to the fixture housing. Provide only fixtures whose design, fabrication, and assembly prevent overheating or cycling of lamps and drivers under any condition of use.


- e. Drivers for fixtures that are inaccessible shall be remote mounted in an accessible location and labeled indicating fixture controlled.
- f. Dimming drivers shall be compatible with 3-wire (Line Voltage), Electronic Low Voltage (ELV) or Digital Addressing as required by lighting control system and fixture manufacturer. Provide identical drivers within each fixture type.
- g. Drivers shall have the lowest sound-rating available for the lamps specified and clearly show their respective sound ratings.
- h. For outdoor use and wherever drivers are used outside a heated environment provide drivers capable of lamp-starting at any temperature down to 0 degrees F.
- i. Drivers shall have a 5-year warranty from date of acceptance of the completed installation.

4. Controls

- a. Lighting fixtures in individual rooms, such as offices and conference rooms shall be provided with wall or ceiling mounted vacancy sensors. Vacancy sensors shall require manual intervention to turn fixtures on, and will automatically turn fixtures off after the space has been vacant for an adjustable amount of time, not to exceed 30 minutes, initially set at 15 minutes.
- b. Lighting fixtures in open areas such as large laboratories and open office areas shall be provided with ceiling mounted occupancy sensors with manual on/off control near the entrances to these areas. When the manual switches are in the on position, occupancy sensors shall automatically turn fixtures on when they sense occupants, and automatically turn fixtures off after the space has been vacant for an adjustable amount of time, not to exceed 30 minutes, initially set at 15 minutes. When the manual switch is in the off position, the lights shall remain off
- c. Vacancy and occupancy sensors shall include additional contacts for the building automation system, to set back temperatures when the space is unoccupied.
- d. Vacancy and motion sensors shall be passive infrared.
- e. Vacancy sensors in bathrooms shall be dual technology passive infrared and ultrasonic.
- f. Daylight harvesting shall be utilized in all spaces where an appropriate level of natural lighting is available.



- g. Lighting controls shall be coordinated with, but not integrated into, A/V controls in classrooms.
- h. Animal holding spaces shall have day/night control, with positive feedback monitoring via a separate photocell on the building automation system. Discuss dawn/dusk dimming requirements with the Users.
- i. All occupancy and vacancy switches shall be Wattstopper or Lutron.

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28 0510 – Existing Building Fire Alarm Systems Description

1. General: Each building is served by a dedicated protected premises fire alarm system that reports alarm, trouble and supervisory events to the HMS Campus Proprietary Supervising Station via a Digitize ISO transmitter.
2. Armenise Building D – 210 Longwood Avenue
 - a. Fire alarm system is manufactured by SimplexGrinnell (model 4100U), and is analog/addressable system with emergency voice/alarm communications. The primary Fire Alarm Control Units are located in the main corridor adjacent to the Courtyard entrance.
3. Building C – 240 Longwood Avenue
 - a. Fire alarm system is manufactured by SimplexGrinnell (model 4100 ES), and is analog/addressable system with one-way Emergency Voice/Alarm Communications. The main Fire Alarm Control Panel is located in the main building entrance from the Courtyard.
4. Countway Library – 10 Shattuck Street
 - a. Fire alarm system is manufactured by SimplexGrinnell (model 4120), and is a high rise analog/addressable networked system with emergency voice/alarm communications. The primary Fire Alarm Control Units are located in a Fire Command Room located adjacent to the building entrance.
5. Goldenson Building – 224 Longwood Avenue
 - a. Fire alarm system is manufactured by SimplexGrinnell (model 4100U), and is analog/addressable system with one-way emergency voice/alarm communications. The primary Fire Alarm Control Units are located in the main corridor adjacent to the Courtyard entrance.
6. Gordon Hall – Building A – 25 Shattuck Street
 - a. Fire alarm system is manufactured by SimplexGrinnell (model 4100), and is analog/addressable system with general evacuation (horn/strobe) signaling. The primary Fire Alarm Control Units are located in the basement level electric room and currently supports a combination of early-generation “MAPNET” devices and a limited number of hardwired initiating zones.



7. Harvard Institutes of Medicine (HIM) – 77 Avenue Louis Pasteur
 - a. Fire alarm system is manufactured by UTC Fire and Security - Edwards (model EST-3), and is an analog/addressable high rise system with emergency voice/alarm communications. Fire Command Center is located in the main lobby.
8. Laboratory for Human Reproduction and Reproductive Biology (LHRRB) – 45 Shattuck Street
 - a. Fire alarm system is manufactured by SimplexGrinnell (model 4100U), and is analog/addressable system utilizing “IDNET” devices with general evacuation (horn/strobe) signaling. The primary Fire Alarm Control Units are located in the building entrance and basement level electric room.
9. New Research Building (NRB) – 255/265 Huntington Avenue
 - a. Fire alarm system is manufactured by SimplexGrinnell (model 4120), and is a high rise analog/addressable networked system “MAPNET” devices and one and two-way with emergency voice/alarm communications. The primary Fire Alarm Control Units are located in a Fire Command Center located adjacent to the building entrance.
10. Seeley G. Mudd - 250 Longwood Avenue
 - a. Fire alarm system is manufactured by Gamewell/FCI (model E3), and is analog/addressable system with general evacuation (horn/strobe) signaling. The primary Fire Alarm Control Units are located in the basement level electric room.
11. Tosteson Medical Education Center (TMEC) – 260 Longwood Avenue
 - a. Fire alarm system is manufactured by SimplexGrinnell (model 4100 ES), and is analog/addressable system with one-way Emergency Voice/Alarm Communications. The main Fire Alarm Control Panel is located in a Fire Command Room adjacent to the main building entrance off of Longwood Avenue.
12. Vanderbilt Hall – 107 Avenue Louis Pasteur
 - a. Fire alarm system is manufactured by SimplexGrinnell (model 4100 ES), and is analog/addressable system with one-way Emergency Voice/Alarm Communications. The main Fire Alarm Control Panel is located in a Fire Command Room adjacent to the main building entrance off of Avenue Louis Pasteur.

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13. Warren Alpert Building – 200 Longwood Avenue

- a. Fire alarm system is manufactured by SimplexGrinnell (model 4100U), with IDNET analog/addressable devices and one and two-way Emergency Voice/Alarm Communications. The main Fire Alarm Control Panel is located in a Fire Command Room adjacent to the main building entrance off of Longwood Avenue.

14. 158 Longwood Avenue

- a. Fire alarm system is manufactured by SimplexGrinnell (model 4010), and is an addressable system with general evacuation (horn/strobe) signaling. The primary fire alarm control unit is located in the basement level of 635 Huntington Avenue. Off-premises reporting is conducted to a remote supervising station via a digital alarm communicator/transmitter; the system does not utilize a Digitize transmitter and does not report to the HMS supervising station.

15. 160-164 Longwood Avenue (Picture deleted)

- a. Fire alarm system is manufactured by Gamewell/FCI (model E-3), and is conventional hardwired system with addressable loop wiring serving duct-mounted smoke detectors, and general evacuation (horn/strobe) signaling. The primary Fire Alarm Control Unit is located in the basement level.

16. 180 Longwood Avenue


- a. Fire alarm system is manufactured by Gamewell/FCI (model FC7200, and is an early-generation analog/addressable system with general evacuation (horn/strobe) signaling. The primary Fire Alarm Control Units are located in the basement level.

17. 641 Huntington Avenue

- a. Fire alarm system is manufactured by SimplexGrinnell (model 4010), and is analog/addressable system with general evacuation (horn/strobe) signaling. The primary Fire Alarm Control Units are located in the basement level (room L108).

18. School of Dental Medicine – 188 Longwood Avenue

- a. Fire alarm system is manufactured by SimplexGrinnell (model 4020), and is analog/addressable system with early-generation “MAPNET” devices, and general evacuation (horn/strobe) signaling. The primary Fire Alarm Control Units are located inside the main building entrance located off of Longwood Avenue.

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19. Research and Education Building (REB) – 190 Longwood Avenue

- a. Fire alarm system is manufactured by SimplexGrinnell (model 4100U), and is analog/addressable high-rise system with one and two-way Emergency Voice/Alarm Communications. The main Fire Alarm Control Panel is located in a Fire Command Center adjacent to the main building entrance.

20. E-Terrace Vault

- a. Fire Alarm panel is a Simplex 4002-Series hardwired panel with general evacuation signals and dedicated digitize isolation (“ISO”) panel for off-premises reporting.

28 0520 – Fire Alarm Design Criteria

1. Design Statement

- a. New fire alarm systems shall be an addressable, microprocessor-based system with system cabinets, power supplies, with Central Processing Unit (CPU) and operator’s display with LCD screen and status indicators and controls, standby batteries, peripheral devices, , one-way emergency voice/alarm communications, etc.
- b. The systems supervise related life safety and emergency systems to include the building fire protection systems and sprinklers, Emergency Responder Radio Systems, and campus Mass Notifications.
- c. System events shall be reported to the campus Security and Boston Fire Department via the existing campus alarm reporting system in accordance with the campus Emergency Response Plans.
- d. Where existing systems are to be maintained or modified, the work shall comply with the Design Criteria stated herein. Work shall include all necessary upgrades to the existing Fire Alarm Control equipment to support the scope of work including control unit hardware and firmware upgrades, devices and wiring with temporary reprogramming, final programming and system re-acceptance testing in accordance with NFPA standards and applicable code.
 - i. The system operation, including event annunciation, occupant notification and fire safety functions shall match existing unless otherwise directed by the Project Manager.
 - ii. New strobe appliances within the work area shall be compatibly-listed for use with existing devices. In the event that new and existing devices are not compatible or if the provisions for strobe synchronization stated in NFPA 72 cannot be met, all devices within the affected area shall be replaced to comply with the applicable Codes.

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iii. All devices and their respective wiring including types, methods, and color-coding shall match existing.

e. Contractor shall coordinate project phasing and impairment plans with the HMS Project Manager and provide temporary protection and system programming to accommodate the phased construction, alteration and demolition activities.

2. Codes, Standards and References

a. The system shall comply with all current applicable codes, including the following:

- i. Massachusetts Building Code (780 CMR)
- ii. NFPA 72 – National Fire Alarm and Signaling Code
- iii. 527 CMR and Massachusetts Electrical Code (NEC)
- iv. City of Boston Fire Prevention Order
- v. All applicable UL standards, including UL864, UL268, UL464 and UL 1971
- vi. Americans with Disabilities Act (ADA) and 521 CMR MA Architectural Access Board regulations.
- vii. Harvard Medical School Emergency Management Plan

3. Impairments and Safeguards

- a. Safeguarding of the building during demolition, alteration and construction shall be a joint cooperative effort involving the entire project team, including the fire protection contractor, the fire alarm contractor, the general contractor/construction manager, owner and all authorities having jurisdiction. The fire protection contractor shall coordinate with any and all parties as appropriate in order to achieve proper safeguarding as described in the project documents.
- b. The Contractor shall ensure proper building protection and safeguarding at all times during demolition, alteration, and construction in complete compliance with all applicable codes, regulations, standards, including but not limited to applicable Building and Fire Codes, and the current edition of NFPA 241.
- c. During times when the existing, modified and/or new building fire protection systems are impaired, the contractors shall provide appropriate safeguarding of the renovation work area, to include temporary heat detection or adequate alternate protection throughout the space as coordinated with, and approved by, the tenant’s and owner’s fire prevention program manager, building manager, construction manager, insurance underwriters, and all authorities having jurisdiction.



Safeguarding shall also apply to all related phasing, shut-downs, swing spaces, temporary facilities and relocations, etc. Detection shall be located and installed in accordance with the products' listing and manufacturer's instructions, and shall be tested and maintained until such time that the permanent building protection is restored. Alternative safeguarding such as, but not limited to, fire watch personnel, or temporary fire protection systems, may be considered if acceptable to the tenant/owner and authorities having jurisdiction. Refer to, and coordinate with, fire alarm systems documents, and safeguarding and impairments notes and specifications. Coordinate with fire alarm system contractor and all other trades.

- d. The contractor shall be required to submit a complete demolition, alteration, construction, phasing and impairment plan to include the information above, a schedule of project milestones and related work, and an anticipated schedule for installation, impairments, programming and all phases of final testing and completion of the work. This plan shall be coordinated with all authorities having jurisdiction, the tenant's/owner's fire prevention program manager, construction manager, and shall include any and all information, drawings, and graphics to meet the approval of the authorities having jurisdiction. The contractors shall provide firewatch personnel or temporary protection as required by any authorities having jurisdiction, the tenant/owner, or the tenant's/owner's insurance underwriters.
- e. All costs associated with the above safeguarding during demolition, alteration, construction, phasing, shutdowns, etc. with regard to fire protection systems shall be included in the contractor's base bid.
- f. Temporary Protection
 - i. The Contractor shall provide temporary protection while portions of the existing fire protection sprinkler system or fire alarm system are impaired or out of service for an extended period (generally 8 hours or more) during construction, alteration and demolition activities.
 - ii. Temporary protection shall be installed throughout the affected areas in accordance with the Contractor's impairment plan and Boston Fire Department requirements. Protection shall include, but not be limited, to the following:
 - 1. Automatic fire detection equipment including smoke detectors and/or temporary heat detectors.
 - 2. Notification equipment including, but not limited to, ADA compliant combination audible/visual notification appliances.
 - 3. Manual fire alarm pull stations.
 - iii. Temporary fire protective devices shall be installed in accordance with the product's labeling, manufacturer's listing requirements and applicable codes.



- iv. Installation of temporary fire protective devices shall be coordinated with the construction, alteration and demolition conditions, and shall account for structural members, ductwork, piping and conduit racks as they occur or are encountered during construction.
- v. Temporary fire protective devices shall be connected to the building fire alarm system and shall function as permanent until replaced with final fire protection and fire protective systems.
- vi. Temporary fire device layout shall be changed as necessary during construction in order to maintain proper coverage including spacing and locations of devices as work progresses and building areas are impacted.
- vii. Bagging or the temporary covering of smoke detectors shall not be allowed during construction, unless specifically permitted by the Boston Fire Department. Where detectors are permitted to remain during construction, they shall be cleaned and recalibrated or replaced prior to system reacceptance in accordance with NFPA 72 requirements.

4. Control Panels

- a. The main control panel shall be a solid-state, microprocessor-based, modular fire alarm control panel. The control panel shall communicate with all peripheral initiating devices and each initiating device shall report to the control panel with an individual device point number and message.
- b. The control panel shall receive all alarms from peripheral devices and remote data gathering panels and initiate a pre-recorded voice message throughout the facility followed by the appropriate audible and visual evacuation signal. Evacuation signals are activated throughout the building in low-rise occupancies, and on the floor of incident plus one floor above and one floor below in high rise buildings.

5. Fire Command Center or Fire Command Station (FCS)

- a. A designated fire command station shall be located at the main entrance to each facility to comply with 780 CMR requirements. The FCS shall house the primary operator’s display indicating all system events and control functions, an LCD display to show device type, status and location, and an audio control panel for selective and all-call one-way voice paging.
- b. High rise buildings shall have a fire command center in accordance with 780 CMR Requirements with H-O-A switches for control and status monitoring of HVAC equipment and an event printer to report all system activity.

6. Building Automation Interface



- a. The fire alarm system shall be interfaced with the building automation system (automatic temperature control system) and HVAC systems to send and receive signals from alarm indicating devices and H-O-A switches for operation of fire safety control functions, smoke control systems, and control of related building ventilation systems.
- b. Dedicated smoke control systems shall comply with UL 864 Category UUKL Requirements; all wiring for smoke control systems shall have a minimum Level 2 Survivability.

7. Alarm Initiating Devices

a. Manual Pull Stations


- i. Manual pull stations shall be provided at each floor egress and shall be spaced, such that the travel distance to any pull station is less than 100'-0".
- ii. Pull stations shall be double-action of the non-coded type with a key reset switch.
- iii. Provide an all-call (general evac.) pull station adjacent to each main FACP/FCS.

b. Smoke Detectors

- i. Smoke detectors shall also be located within electric rooms, elevator lobbies and control rooms, and at other locations as required by code. Smoke detectors shall be photoelectric type. Beam detectors or air-sampling smoke detection shall be located in open wells as well as large open areas in lieu of photoelectric smoke detectors.
- ii. Duct-mounted smoke detectors shall be located at each air handling unit with a capacity greater than 2000 CFM to initiate unit shutdown, and at smoke dampers or combination fire/smoke dampers to initiate damper control functions. New duct detectors shall be photoelectric-type and programmed for Supervisory event reporting as permitted by 780 CMR.
- iii. Photoelectric smoke detectors shall be provided in each lab space, except where ambient conditions dictate that another type of early-warning detection be used (such as heat detection or air-sampling smoke detector, etc.)

c. Heat Detectors

- i. Heat detectors shall be provided in all environmental rooms.

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- d. Alarm Verification: Smoke detectors shall be capable of employing alarm verification features whereby the system will confirm through a verification period or the activation of (2) smoke detectors to initiate an alarm condition prior to initiating the occupant notification sequence. Alarm verification is only permitted to be employed where necessary, and shall be subject to the review and approval of the Owner and Fire Official.

8. Alarm Notification Appliances

- a. Visual strobe units shall be provided in all public use and common use areas including work areas, environmental rooms, dark rooms, machine shops, roof tops, and shall meet the public mode signaling requirements of ADA, UL, and NFPA.
- b. Audible units shall be speakers with a peak output of 88 dB at 10'-0", and shall be spaced to produce a minimum of 15dbA above ambient throughout the building.
- c. Audible units in mechanical areas or other areas with high ambient noise shall be trumpet type loudspeakers suitable for such locations to ensure the 15dbA above ambient is achieved.
- d. Devices shall be predominantly red in color; where speakers are used for emergency signaling, the device shall not be labeled "FIRE" or have any other signifying marks to restrict its use for fire alarm only.

28 3100 – Fire Alarm System

1. Fire Alarm Control Panels

- a. Fire alarm control panels shall be located on every third floor to provide fire alarm service termination to the floor on which it's located, the floor above and the floor below. Each panel shall communicate directly with the main fire alarm control panel and fire command center. Each remote panel shall be a fully functional self-contained and self-sufficient unit such that, if the connection to the control processor is severed, (a trouble indication shall sound) the panel will continue to function and sound appropriate alarms based on the last set of programming instructions received.
- b. Terminal cabinets shall be used on all other floors to provide service terminations between the vertical riser (trunk wiring) and horizontal floor circuits (branch wiring).
- c. Systems shall be provided by Simplex Grinnell or approved.
- d. Provide a 120V convenience outlet and Cat-5 TCP/IP Network drop adjacent to each fire alarm panel.



2. Elevator Interface

- a. The fire alarm system shall be interfaced with the elevator equipment and provide emergency elevator functions, to include primary and alternate recall, fire hat indication and hoistway ventilation control.

3. Wiring

- a. All fire alarm wiring shall be Class "A" supervised circuits.
- b. Fault isolation shall be employed to ensure that a single wiring fault will not affect more than one floor or evacuation zone.
- c. All wire and cable shall be suitable for fire alarm use and shall be installed in conduit (Level 1 survivability) as determined by the Project Manager.
- d. Where selective or partial evacuation is employed (such as high rise buildings), all circuits necessary for occupant notification shall have a minimum Level 2 Survivability from their point of origin until they enter the evacuation zone served.

4. Device Labeling and Identification

- a. Each system device shall be labeled and identified using P. Touch Labeling System or equivalent. Nomenclature shall include the programmed device address, and device nomenclature labeling to comply with HMS Standard as follows:
- b. Device Nomenclature Labeling

Building	Address	Facility Letter	Floors, Bsmt, Penthouses, Roof, Mezz.	Fire Detection Devices	Detection Device Acronym
180	180 Longwood	F	3 + L, R	Smoke Detector	SD
641	641 Huntington	J	4 + L, R	Duct Smoke Detector	DSD
158, 160 & 164	160, 164 Longwood	H	4 + L	Heat Detector	HD
Armenise	210 Longwood Ave.	D	6 + L	Audio Visual	AV
C Building	240 Longwood Ave.	C	6 + L, P	Pull Station	MS
Countway	10 Shattuck St.	W	6 + L1, L2, R	Door Holder	DH
Dental	188 Longwood	T	2 + L	Control Module	CM
Goldenson	220 Longwood Ave.	B	5 + L, P	Monitor Module	MM
Gordon Hall	25 Shattuck Street	A	5 + L, M	Remote Indicator	RI
HIM	4 Blackfan Circle	P	10+L+P	Flow Switch	FS
LHRRB	45 Shattuck St.	L	6 + L, R	Tamper Switch	TS
Mudd	250 Longwood Avenue	M	6+1+1	Water Flow	WF
NRB	77 Avenue Louis Pasteur	S	10+L+P	Strobe Light	SL
TMEC	260 Longwood Ave.	E	4 + L, M	Fire Panel	FP
REB	190 Longwood Ave.	K	5 + L, M	Digitizer	D
Vanderbilt Hall	107 Ave. Louis Pasteur	V	6 + L1, L2, P	Smoke Detector w/ Remote	SDR
Warren Albert	200 Longwood Avenue	Q	5+L+P	Duct Smoke Detector w/ Remote	DSDR

<p>Nomenclature Example T-SD3-0001 T Facility SD Smoke Detector 2 Floor 1 Number in Series</p>					
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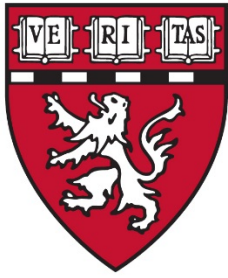
- c. All device labeling shall be coordinated and reflected on the Tier 3 As-Built Record Documents.

5. Record Documents

- a. The Contractor shall provide complete as-built Tier 3 Record Documents in accordance with NFPA 72 and 780 CMR Requirements. Documents shall include electronic and paper copies of the following: (chart deleted; inserted under #4, b.)
 - i. Updated shop drawings showing the final as-built conditions.
 - ii. Battery calculations and notification circuit voltage drop calculations.
 - iii. NFPA Matrix / Sequence of Operation
 - iv. Test and Inspection Report
 - v. Updated NFPA Record of Completion

6. Testing

- a. The entire system shall be tested to the satisfaction of the Owner after which a final acceptance test witnessed by the local authority, the Owner's Building Construction Department, Risk Management Department and Security Department Representatives as follows
 - i. First Party Test: A full and complete test in accordance with NFPA Requirements and applicable code shall be conducted by the Installing Contractor and system supplier.
 - ii. Third Party Test: A full test shall be conducted by the Owner's designated representatives (Service Company of Record – Aetna Alarms), or Commissioning Agent as directed by the Project Manager. The Installing Contractor and system supplier shall participate during these tests and will resolve any outstanding issues to the Owner's satisfaction.
 - iii. Fire Department Acceptance Testing: The Installing Contractor shall be responsible for coordination and final acceptance testing to comply with BFD Requirements.



HARVARD MEDICAL SCHOOL

Owner's Project Requirements (OPR)

Project Name
Address
City, State

Prepared By:

Date:

REVIEWERS:

Owner/ HMS Project Manger

Name

Date

Architect

Name

Date

Engineers (MEP)

Name

Date

Facilities Representative

Name

Date

Commissioning Authority

Name

Date

Project Name, City, State
Owner's Project Requirements
DATE

Overview

The Owner's Project Requirements document is a written document completed by the Owner or Owner's Representative. This document will be used as the outline for the more detailed and technical Basis of Design (BOD) document. Both the OPR and BOD inform, direct, and guide the design and construction process. These documents must be reviewed by the Commissioning Authority for clarity and completeness.

The Owner's Project Requirements document should be completed prior to the start of design and provided to the design team. The design team should assist the Owner in the development of this document within the initial project workshop or visioning session. Updates and revisions to the Owner's Project Requirements document throughout the course of project delivery should be completed by the Owner or Owner's Representative based on decisions and agreements coordinated with the project team.

The intent of the Owner's Project Requirements (OPR) document is to provide a record of the building's owner and end-users objectives and criteria for the building system. The Owner's Project Requirements is required for compliance with LEED-NC EA Prerequisite 1 for Fundamental Commissioning of the Building Energy Systems as well as EA Credit 3 for Enhanced Commissioning, and will be used during the design and construction process to evaluate the success.

This template has been provided as an example Owner's Project Requirements document. If used for the project it should be edited to meet the project needs. The use of this document is not required for the Owner's Project Requirements, but it is outlined based on the LEED Reference Guide for Green Building Design and Construction Owner's Project Requirement criteria.

Owner and User Requirements

What is the anticipated project schedule? (Provide construction start date, substantial completion date, occupancy date, etc.)

What is the primary purpose, program, and use of this project; what areas are required for a functional facility? (*e.g., office spaces, conference rooms, data center, maintenance storage, restrooms, etc.*)

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Are there any special construction processes? *(e.g., phasing, access, occupancy, adjacencies)*

Describe any goals relative to project needs. *(e.g., future expansions, flexibility, quality of materials, and construction, maintenance, and operational costs)*

What problems with previous projects should be avoided? *(e.g., inadequate HVAC system performance, inefficient space utilization, poor acoustical qualities)*

What must be accomplished for a successful project?

Environmental and Sustainability Goals

How do we measure the sustainability of the project *(e.g., Owner's priorities among possible LEED points)*

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Energy Efficiency Goals

What are project's over all energy efficiency goals? (e.g., local energy code, ASHRAE standards, LEED)

What are the energy efficiency goals or requirements that will effect energy use? (e.g., building orientation, landscaping, façade, enveloped and roof features)

What are energy efficiency measures that provide cost effective energy savings? (e.g., natural ventilations, day lighting, landscaping, etc.)

How will the building design be benchmarked? A benchmark is a standard which the facility design, construction, and performance is measured against. (e.g., Design for Energy Star, 2030 Challenge, corporate protocol, LEED)

Indoor Environmental Quality Requirements

What are the thermal comfort and air quality requirements? (e.g., desired temperature and humidity setpoints normal and after hours, after hour use of facility- occupancy overrides/schedule protocol, building pressure, desired user ability to adjust controls, operable windows, filters). Refer to HMS Design standard in BAS section 25. **Specify any exemptions or specialty room parameters.**

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DATE

What is the anticipated building occupancy schedule?

What are the lighting requirements? *(e.g., types of lighting, illumination levels, lighting control – dimmers, daylight sensors, motion sensors, time clocks)*

What activities generate pollutants in/near this building which impact health, hygiene and indoor environments? *(e.g., Copy Rooms, chemicals or paints stored on site, smoking)*

Equipment and System Expectations

What are the equipment and system expectations? *(e.g., quality, reliability, type, automation, flexibility, and maintenance requirements and accessibility for each system)*

Provide specific targets, desired technologies, or preferred manufacturers for building system, if any.

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Building Occupant and O&M Personnel Requirements

How will the facility be operated; HVAC and lighting control systems? Who will operate the facility?

(Examples: Animal Facility, specialty lab rooms, DNA suite, server room, etc.)

Who will conduct periodic HVAC and lighting control system maintenance?

What is the desired level of training and orientation for building occupants to understand and use the building?

What is the desired level of training and orientation for O&M staff to understand and maintain the building?

What documentation is required to properly operate and maintain facilities?

Describe any special system warranty expectations?

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Additional Special Project Requirements Not Already Covered

Indicate any special considerations and project requirements:
