UNIVERSITY OF LOUISVILLE

PROCUREMENT SERVICES
ADDENDUM

Date of Notice:	6/23/2025
Solicitation No.:	RFP340-PSC
Title:	Commissioning Services for New Health Science Simulation, Academic, and Innovation Facility
Addendum No.:	One (1)

The following shall clarify and/or modify the original bid document(s) as issued by the University of Louisville.

1. ATTACHMENTS

a. Attached hereto is the sign-in sheet for the Pre-Bid meeting held on June 4th, 2025.
b. Attached hereto are three (3) PDFs:
    i. Electrical
    ii. Mechanical
    iii. Plumbing/FP.
c. Attached hereto is an ASTM E2813 table indicating which tests are required for this project.

2. VENDOR QUESTIONS & ANSWERS

Q1. Can you elaborate on what "net zero ready" entails for this project?

A1. Net Zero Ready includes the following:

- Energy Efficient MEP Systems

- Electrical infrastructure sized and structured for future PV generation to include space for inverters, electrical panels and other PV specific infrastructure

- Empty home-run conduit sized to support proposed PV Locations

- Structural capacity for roof mounted ballasted PV

- Roof membrane selected and design for roof mounted ballasted PV

Q2. Are there any specific sustainability performance targets beyond LEED Platinum?

A2: Net Zero Ready is currently the most significant target beyond LEED Platinum.

Q3. Is there a preferred format or template for the OPR?

A3. To be developed during design.

Q4. Are there existing UofL design standards available, or that are referenced by the design team?

A4. Narratives provided with this addendum, once awarded we could provide other projects to aid in the development of commissioning specs/design with the Design team.

Q5. Confirm Basis of Design (BOD) is to be provided by the design team and reviewed by Cx.

A5. Design team will develop the BOD and the Cx team with UL will develop the OPR.

Q6. Are the following to be included in the Cx scope: photovoltaic, wind generation, medical gases, other renewable energy systems. Will be installed in the initial construction or designed for future phases?

A6. Photovoltaics, and med gasses will be included in the project.

Q7. Will the CxA be responsible for submitting to LEED Online directly, or will this be routed through the LEED consultant?

A7. The CxA will be responsible for directly submitting to LEED Online; responding to LEED Review questions; and vigorously defending the submittal.

Q8. Will the same facilities staff responsible for long-term operation be available during commission for training and documentation review?

A8. Yes

Q9. Are there any fixed milestones for design completion (SD, DD, CD) and construction start?

A9. See response 2 in clarification response.

Q10. Is there an established sequence or schedule for phased occupancy or commissioning?

A10. No phased occupancy - LEED Fundamental and Enhanced Commissioning will be sequenced as recommended by the CxA in collaboration with the Owner, AE Team, and Builder. The CxA is to develop a Plan, including sequencing for Monitored Commissioning.

Q11. What are the constraints or expectations for on-site presence during construction and testing?

A11. To be coordinated with the owner and CMGC. Some things may be required on weekends or off hours. Most should be able to be accommodated during work hours.

Q12. Will the university consider reimbursable expenses separately or must they be included in the lump sum fee?

A12. Can be included in lump sum.

Q13. Can you confirm whether escalation should be factored into pricing given the multi-year duration?

A13. Your price should be inclusive of project timeline.

Q14. Please provide an estimated equipment list.

A14. See attached narratives.

Q15. Please clarify if the CxA develops the OPR and if the Architect develops the BOD.

A15. The design team will develop the BOD and the Cx team with UL will develop the OPR.

Q16. Please clarifiy who is to execut the checklists, the CxA or the Contractor?

A16. Execution of checklists will be completed by Cx agent.

Q17. Does the CxA need to witness O&M Staff training and does witnessing include video recording?

A17. Yes, and yes.

Q18. Does the CxA need to perform Building Envelope testing? If so, please provide list of tests and quantities to be performed.

A18. See response 3 in the clarification response, as well as attached E2813-18 with markups.

Q19. Are there fixed milestones for CxA review of GCCM pricing questions?

A19. Pricing during design would be at the milestones given by the A/E on this addendum.

Q20. Post Construction Quarterly Functional Testing - Should we expect to perform a site visit or just trend reviews of the central HVAC systems?

A20. A site visit is expected.

Q21. Is there a limit to page count of proposal response?

A21. Maximum 75 pages.

Q22. Are the references to be company references or team member references?

A22. Company for projects that are comparible, we would like to see who on the proposed team was also involved in those projects.

Q23. One item that we do question is the lack of specificity to the building enclosure commissioning. Our cx industry has failed to coalesce around a standard definition of process for BECx and which party completes specific tasks in the process. With this RFP being 35% pricing, the definition of a scope of services seems critical to being able to respond. We know what we have delivered for UofL in past projects and suspect that is the level of care anticipated. However, would it be possible to please ask the project team to prepare a scope of services including clarity on which test should be included and which contracting party will be responsible to perform the building enclosure testing?

A23. Building envelope commissioning is noted. Specs are not an option as it's part of the design they will be assisting with making. The proposer or a company they want to partner with for building envelope commissioning and include as part of their scope in the proposal. In case the commissioning company doesn't have building envelopes as their services.

Q24. Is a preliminary project schedule, including design phases and construction duration, available for review?

A24. Design and Construction Phase Scheduling is loosely outlined below, but is subject to change as the project moves forward. The milestones below do not include early bid packages, only final phase milestones.

Schematic Design	completed by 9/1/25
Design Developement	completed by 1/1/26
Construction Documents	completed by 7/1/26
Final Completion of Construction	completed by 4/30/29

Q25. Please confirm that the intended scope of Building Enclosure Commissioning (BECx) services shall be as defined in applicable activities listed in Table 1 and Table 2 of the RFP and not limited to the requirements of LEED v4.1.

A25. Meet all LEED V4.1 Option 2. Building Enclosure Commissioning requirements for envelope commissioning, and at a minimum meet the ASTM E2813-18 Standard Practice for Building Enclosure Commissioning Fundamental criteria. Refer to the attached TABLE A2.1 BECx Performance Testing Requirements highlighting the minimum Mock-up and / or in-field testing required by the project. Include other tests if deemed to be required for LEED V4.1 compliance. The project is in early Schematic Design and detailed elevations and plans are not available.

Q26. Please verify the anticipated scope of building enclosure testing. Is the expectation for the CxA to perform and/or retain a testing agency for enclosure tests, or solely to witness testing by others?

A26. See attached E2813-19 with markups.

Q27. Please provide guidance as to anticipated frequency and/or total number of requested BECx field observations.

A27. As required within the attached E2813-19 with markups.

Q28. Has a design narrative been developed to better understand the projected quantities of major equipment (i.e Emergency Electrical Distribution, Normal Electrical Distribution, size of photovoltaic array, Quantity of Heat Pump Chillers, etc.)?

A28. See attached Narratives.

Q29. Is there a Schematic Drawing of the building showing floor plan layouts to provide better estimating on terminal water source heat pumps?

A29. Yes, and will be addressed upon award.

Q30. What phase of the project do they want to start commissioning?

A30. More information needed.

Q31. Will we be assisting in OPR/BOD development?

A31. Yes

Q32. Will there be any building envelope commissioning?

A32. See response to Question 3.

Q33. Is there a preliminary project schedule?

A33. See response to Question 2.

Q34. Will there be any factory witness testing?

A34. Response: As required within the attached E2813-19 with markups.

Q35. Please define the requirements for the building envelope performance testing. Previous UofL LEED projects required whole building air leakage testing including thermal imaging. Additionally, will the project require water spray testing? LEED reviewers for projects we have submitted on in recent years have consistently required a water spray test to be included. The commissioning firm would not necessarily have to perform the test. The specifications could incorporate this requirement for the contractors and the CxA could witness to confirm the testing is being performed per the appropriate test method. We have included the LEED review comment below for further reference.

a. "For future projects, ensure that the required field water testing is part of the envelope commissioning scope because moisture protection is a primary function of the building envelope. Refer to Further Explanation>Building Envelope Commissioning Basics in the LEED v4 BD+C Reference Guide and Annex U of NIBS Guideline 3-2012 for examples of envelope systems tests that may be performed and further guidance."

A35. See response to Question 3.

Q36. What is the project construction schedule duration?

A36. Response: See response to Question 2.

Q37. How complete is the current design? Can drawings/design narratives be shared for pricing purposes?

A37. Response: MEP & Envelope narratives are attached to this addendum. Other design drawings/narratives are still early in design. As noted in the RFP the prime function of the building is for simulation – Inpatient, outpatient, standardized patient, Dental, skills labs, etc. not seeing real patients. Workplaces for the sim staff, and relocating the school of public health, classrooms, some research space, lots of student/public spaces, a café/dining area, outdoor space(s), etc.

Q38. The Commissioning RFP notes Enhanced Commissioning includes Option 1 Path 2 but does not explicitly state Option 1 Path 1 is required. Since that is a prerequisite for Option 1 Path 2 it is reasonable to assume Option 1 Path 1 is required, but we would like to confirm that is the expectation. The deliverables for this credit are listed in the RFP except for developing training requirements for operator training (training plan) and developing the Ongoing Cx Plan.

A38. This is a reasonable assumption.

Q39. FPT sampling is not mentioned in the Commissioning RFP, but LEED allows sampling strategies to be implemented on some systems. Can you confirm if FPT sampling would be permitted, or if the expectation is to avoid sampling during the FPT's? Please indicate specific unit types if possible. We would assume simple terminal units of the same type might be subject to sampling, but would more complex terminal units such as chilled beams or Phoenix valves be subject to sampling as well?

A39. Response: At this point sampling is not allowed, all systems to be commissioned.

Q40. Can you confirm the commissioning meeting and site observations expected frequency during the construction phase of the project? When MEP systems begin installation (including building envelope review) we have had previous UofL project experience where the expectation was biweekly site reviews of the installation and monthly commissioning meetings.

A40. Response: To start monthly meetings, seem adequate but closer to completion would require weekly (virtual can be accommodated/coordinated). Site visits are not required bi-weekly in early construction but a safe assumption for when MEP systems begin installation (including building envelope review). These cadences can be coordinated as these might flex through the project as needed.

Q41. The RFP indicates that the CxA is to provide an 8-10 month post occupancy check as well as a 12 month follow-up. Will these site visits be in addition to the required LEED 10th Month Warranty Review, or could those deliverables be consolidated into the LEED 10th Month review.

LEED minimum commissioned systems requires renewable energy systems, will any systems of this type be included in the project?

A40. Response: A photovoltaic array will be included in this project. The size of the system is not yet determined.

Q41. Are any systems beyond what is shown in the RFP scope of services and the minimum required LEED systems included in the commissioning scope of work? (Vacuum, Medical Gas/Air, etc.)

A41. Response: See attached draft concept narrative that outlines expected systems.

Q42. What is the duration of the project?

A42. Response: See response to Question 2.

Q43. Table 1 indicates the Cx provider will be developing both OPR & BOD. Typically, the engineer or record develops the BOD. This also conflicts with line 2. Under section A. Fundamental Commissioning Services – LEED Prerequisite (refer to LEED v4.1) which states "**Review** and **document** Owner's Project Requirements and Basis of Design"

A43. Design team is developing the BOD.

Q44. Table 1 indicates the Cx provider will be completing the installation checklists; however, these are typically completed by the installing contractor. The Cx provider typically completes the functional performance tests. Can you confirm who you want completing the installation checklists?

A44. Contractor completes, CxA reviews/verifies and completes functional performance tests.

Q45. Can attendance of the SD, DD and CD owner review meetings be virtual?

A45. Response: I would expect some attendance to be in person, other design meetings could be done virtually.

Q46. Table 1 indicates the Cx provider conduct a 12-month post construction follow up. This is typically done at 9-10 months prior to the warranty expiration date. Does the University plan to have a 1 or 2 year warranty? If a 1 year warranty, then we recommend a 9 month follow up visit. If a 2 year warranty, then it may make sense to push the warranty visit out further than 12 months or have a second visit. Please confirm if you would prefer two post occupancy visits or one and when you would like them

A46. 1 year warranty.

Q47. Regarding monitored-based commissioning, who will be furnishing the Energy Management and Information Software required for the monitored-based commissioning?

A47. Mockup Extents and Details Clarification – Mockups should simulate the actual installation conditions and integrate various materials and systems to assess compatibility and performance.

a. Wall Systems Clarification – Assume three (3) wall assemblies:

    1. Extent: Typically one full structural bay wide by one full story high plus additional height to connect to assemblies below and above.

    2. Details:

        1. Includes a typical wall to interior floor slab connection.

        2. Includes an interface between window and wall.

        3. Size: Minimum of 100 square feet.

b. Roof Systems Clarifications – Assume five (5) parapet or roof edge conditions

    1. Details: Include parapet or roof edge conditions and typical penetrations like pipes and dunnage.

    2. Size: Minimum of 100 square feet.

    3. Provide a breakout of the number or required performance tests called for on Table A2.1 being proposed.

    4. Provide a Unit Price for performing each performance test.

Bidder must acknowledge receipt of this and any addenda either with bid or by separate letter. Acknowledgement must be received in the Department of Procurement Services, Service Complex Building, University of Louisville no later than **07/08/2025 at 2:00PM, EST.** If by separate letter, the following information must be placed in the lower left-hand corner of the envelope:

Solicitation No.:	**RFP340-PSC**
Title:	Commissioning Services for New Health Science Simulation, Academic, and Innovation Facility
Due Date:	**07/08/2025**

Authorized By:

Procurement Services	Jamie D. Peck Jamie D. Peck Digitally signed by Jamie D. Peck Date: 2025.06.23 13:35:23 -04'00'

Receipt Acknowledged:

Company	
Signature	
Name (print)	
Date	

UNIVERSITY OF LOUISVILLE.

Pre-Proposal Meeting Sign-In Sheet

RFP Number:	RFP340-PSC
RFP Title:	**Commissioning Services** New Health Science Simulation, Academic, and Innovation Facility (HSC)
Date:	6/4/2025

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Electrical Design Narrative

General

The following Conceptual Narrative describes the Electrical work associated with the proposed 235,000 gross square foot facility located on the Health Science Campus at the University of Louisville.

Codes & Standards

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. Where code references are given, the latest issue of that code in effect at the time of bidding shall be used. Refer to the following Codes, Standards and Regulations:

- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- American Society of Heating and Refrigeration (ASHRAE)
- National Fire Protection Association Codes and Standards (NFPA), including the following:
    - NFPA 70 National Electrical Code (NEC) (2023)
    - NFPA 101 Life Safety Code (2018)
    - NFPA 72 National Fire Alarm and Signaling Code (2013)
    - NFPA 780 Standard for the Installation of Lightning Protection Systems (2014)
- National Electrical Manufacturer's Association (NEMA)
- Occupational Safety and Health Act (OSHA)
- Standards of Underwriters Laboratories (UL)
- Americans with Disabilities Act Standards for Accessible Design (ADAAG)
- Environmental Protection Agency (EPA)
- International Building Code (IBC) (2015)
- International Existing Building Code (2015)
- International Fire Code (2015)
- International Mechanical Code (IMC) (2015)
- Kentucky Building Code (KBC) (2024)
- International Energy Conservation Code (IECC) (2012)
- Kentucky Existing Building Code
- Louisville Land Development Code (January 2025 Update)
    - louisville-metro-land-development-code-january-2025
- Illuminating Engineering Society of North America Handbook 10th Edition (IESNA)
- LG&E Electrical Service Customer Guide (March 2025)
    - KU-Electrical-Customer-Guide-March2025.pdf

- Any applicable Local and State Codes – Latest Approved Editions

Seismic Design Considerations

All electrical equipment, conduits, etc. shall be seismically braced per Kentucky Building Code. Seismic Design Category is assumed to be B at this time.

As such, seismic restraints for MEP components are not anticipated. If the Seismic Design Category is determined to be a C, then the following will apply:

Per ASCE 7 – Minimum Design Loads and Associated Criteria for Buildings and Other Structures the component importance factor (IP) shall be assigned as 1.5 for all components that meet any of the following criteria:

- The component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems and egress stairways.
- The component is in or attached to a Risk Category IV structure and it is needed for continued operation of the facility, or its failure could impair the continued operation of the facility.

Generally, these systems include the life-safety and fire protection systems. All other components are to be assigned a component importance factor (IP) equal to 1.0.

Per section 13.1.4 Exemption item 5, "Mechanical and electrical components in Seismic Design Category C provided that the component importance factor, IP, is equal to 1.0" are exempt from additional seismic requirements.

Power Distribution

Site Power

Power for this facility will be served from a new LG&E Vault connected to the downtown LG&E power grid. Multiple LG&E submersible transformers will be networked together and located below grade in the LG&E Vault. Proposed location for the Vault will be at the corner of S Preston St and E Gray St. The vault and lid will be at least 21' x 50' in size. For shoring, LG&E will require a minimum of 10' from any structure or footings to the edge of the Vault. No part of the Vault may be in the street. The primary duct bank extension would be provided by LG&E from the corner of S Floyd St and E Gray St. Approximate cost to the Owner from LG&E is between $1 million and $2 million for the extension.

Two (2) 3000-amp, 277/480-volt secondary service laterals will be installed from the LG&E Vault to the Main Electrical Room Switchboards. Each secondary service lateral will be eight (8) sets of (four (4) #500kcmil in schedule 80 PVC conduit).

Power will be distributed to site lighting, emergency call boxes, manholes, and miscellaneous 120V end use loads as necessary.

Facility Power

The Main Electrical Room (minimum of 1000 sqft) will house (2) 3000-amp, 277/480-volt Main Service Switchboards. Adjacent to the Main Electric Room will be the Main Emergency Electrical Room (minimum of 450 sqft). Three (3) 200 sqft sub-electrical rooms (A, B and C) will be provided on each floor and are to be stacked for distribution.

Two (2) 3000-amp, 277/480-volt Main Service Switchboards will be located in the Main Electrical Room. Each Switchboard will receive eight (8) sets of (four (4) #500kcmil in schedule 80 PVC conduit) from the LG&E Vault. The main switchboards will have a surge protection device (with event counter) and the main breaker will be 100% rated with electronic trip and ground fault protection (LSIG). Building power metering will be installed per campus standards and interfaced with the building management system (BAS).

Distribution to the panelboards will consist of conduit and wire. Each distribution panel will be fed via conduit directly from one of the Main Service Switchboards; feed-through distribution panels will not be used. This approach allows electrical isolation of each distribution panel without affecting loads served from other panels.

480Y/277V distribution will be accomplished with A, B and C conduit risers (to sub-electrical rooms), where each riser supplies power to one third of the building. Each riser will deliver power to a distribution panelboard (per floor) that will supply power to a normal power mechanical panelboard and a 480:208Y/120V floor mounted distribution transformer for the same level. Floor mounted distribution equipment will be installed on a 4” high concrete housekeeping pad.

Each 208Y/120V secondary distribution transformer will deliver power to a 208Y/120V distribution panel which will supply power to the branch circuit panelboards.

The normal power distribution panels, transformers and branch circuit panelboards will be located in three (3) electrical rooms on each floor. In general, panelboards will not be rated less than 150A.

480Y/277V panels will be located in each electrical room for mechanical equipment. 208Y/120V panels will be located in each electrical room for lighting, receptacles and small motor loads. Panelboards will have copper bussing and will have 25% spare capacity. All panelboards will have a surge protection device (SPD) with event counter.

The fire pump will require dedicated feeders to the fire pump transfer switch and controller. These feeders will be served from:

- Bus tap before the main circuit breaker in one of the main switchboards (480V).
- Generator output circuit breaker (480V).

Lamacoid labels will be provided for all electrical power distribution equipment with an equipment naming scheme approved by the University.

Emergency Power

An exterior 480Y/277V diesel emergency generator with a 24-hour belly tank will be provided for emergency power requirements. This generator will serve the fire pump, supply egress lighting, fire alarm systems, elevator(s) and selected optional loads. Preliminary calculations indicate an 800-kW generator will be required. Automatic transfer switches will supply the fire pump, legally required emergency loads, and optional standby loads. The generator will have a sound attenuated enclosure. Generator alarms will be interfaced to the building management system (BAS).

The legally required emergency system will be supplied by a dedicated 480Y/277V automatic transfer switch. This will provide power for emergency egress lighting, the fire alarm system, egress door operators, and generator accessories.

The optional standby system will be supplied by a separate 480Y/277V automatic transfer switch. This will provide power for select receptacles, refrigerators, security systems, IT equipment, elevators, and select mechanical pumps.

Following to be backed-up at a minimum:

- Code required egress lighting
- IT wiring closets
- DDC head-end equipment
- Selected general purpose receptacles
- All Refrigerators/Coolers/Freezers
- Sump Pumps
- Complete Fire Alarm System
- Complete Video Surveillance System

Provide MI cable for all life safety feeders.

A Generator Connection Cabinet (GCC) will be provided to allow a portable generator or load bank to be connected at street level. This is utilized to facilitate testing and to provide generation should the generator be out of service.

Lighting

General

The lighting will be designed per University Standards and IESNA recommendations. The lighting and controls will meet the requirements of the International Energy Conservation Code.

The lighting system will be designed at 120V. An LED lighting source will be used throughout the building to reduce maintenance costs and to provide energy savings. All lighting sources will be 3500 Kelvin color temperature.

Emergency egress lighting throughout the facility will be powered by the standby generator. Code required egress corridor lighting will be connected as night lights to operate 24/7. Other egress

lighting will be provided with an automatic transfer relay to allow local control during normal operation.

Outdoor lighting meeting University standards will be provided at walkways and entrances into the building. Building façade lighting will also be provided.

Lighting in the stairwell spaces will consist of LED wall mounted direct/indirect fixtures with integral occupancy sensors. These fixtures will be bi-level and operate at 50% when unoccupied and will go to 100% when occupied.

Exit signs will be die cast aluminum connected to emergency power. Ceiling or wall mounted as necessary for the location.

Light levels

Spaces will be designed for average maintained horizontal illuminance levels as noted below:

- Labs 75-100 fc
- Lecture Halls / Classrooms 40-50 fc
- Offices 30-40 fc
- Conference Rooms 50-75 fc
- Admin Support Spaces 30-40 fc
- Corridor / Lobby / Stairwell 15-20 fc
- Support Areas 10-20 fc
- Exterior Building Entrances 5 fc
- Restrooms 30 fc
- Electrical/Mechanical Rms 20 fc
- Telecommunication Rooms 20 fc
- Elevator Machine Room 20 fc
- Elevator Pit 10 fc

Lighting Controls

The building lighting will have automatic shutoff controls based on occupancy and time of day. Basis of design to be Acuity nLight or equal by Wattstopper DLM.

Occupied spaces will have full dimming control. Normally unoccupied spaces, such as restrooms or storage rooms, will be on/off control only. Additional controls and/or task lights may be required to meet LEED v4 Controllability of Lighting credit.

Entry and corridors will be connected to time-of-day controls. Time-of-day controls will be provided by local networkable relay controls located near the lighting loads. These areas will have local occupancy sensors for override to ON during normally scheduled off times at night. This system will interface with the Building Automation System for ease of reporting, programming, and scheduling.

Offices, and small support rooms will be provided with stand-alone dual-technology vacancy (manual on/auto off) sensors with dimming control. Select areas will be provided with an input/output module for reporting of occupancy status to the mechanical BAS system.

Daylight harvesting and multi-level control of lighting will be provided in accordance with energy code requirements.

Emergency lighting that is desired to be controlled with adjacent normal powered lighting will utilize a UL 924 listed control relay to automatically turn lights to on at full output upon a power failure.

Exterior lighting will be controlled by a combination of time-of-day controls and outdoor photocell.

Grounding and Bonding

The reference ground for the equipment grounding system will be established from a structural ground grid as follows:

A #4/0 bare copper ground wire will be installed at 30" below grade around the entire perimeter of the building. 3/4"x 10 ft driven copper ground rods (test wells) will be installed and connected to this ground loop at not-greater-than 200' intervals with a #4/0 bare copper conductor. Steel columns in exterior walls will also be connected to this ground loop with #4/0 bare copper at intervals not to exceed 60'. Interior steel columns will be connected to the exterior ground loop on each side of the building at intervals not to exceed 200' with a #4/0 bare copper conductor.

An "ufer" ground will be provided in the footing of the building consisting of 50' of #500 kcmil wire located 3" from the bottom of the footing.

Wall-mounted copper ground bus will be located in the Main Electrical Room, floor electrical rooms, and voice/data rooms. The main electrical room ground bus will be connected to the "ufer" ground.

Distribution

For grounding and bonding the separately derived systems and sensitive equipment on each floor, bare #4/0 minimum grounding electrode conductors will be provided from the main electrical room reference ground bus to a room ground bus in each electrical room. The conductors will be installed in steel conduit, will daisy chain between room ground buses will be color coded green or a continuous green color with one or more yellow stripes.

A bare grounding electrode conductor (sized per TIA-607-B) will be provided from the main electrical room reference ground bus to a ground bus in each telecommunication room (TR) which will be used for grounding and bonding of equipment. The conductor will be installed in steel conduit daisy chained between room ground buses.

Additional bare #4/0 minimum grounding electrode conductors will be provided from the Main Electrical Room reference ground bus to the underground incoming water service ahead of meter,

ground loop and ufer ground. Grounding electrode conductors will be installed in steel conduit when exposed above grade.

A separate equipment grounding conductor will be provided for all power circuits.

Equipment Connections:

Power connections and code required disconnecting means will be provided for all HVAC, Plumbing, and kitchen equipment in the facility and on the site. Combination starter/fusible disconnects and variable frequency drives (VFD's) will be provided for selected equipment as required. All disconnects shall be heavy-duty type. All exterior and kitchen equipment disconnects will be provided with NEMA 3R enclosure.

A shunt-trip disconnect switch will be provided to serve the elevator controllers and it will be integrated with the fire alarm system to provide for emergency shut-down. A second disconnect will be provided for the elevator lights and fan. Additional lighting and devices will be provided in the hoist way to meet code requirements.

Lightning Protection System

A lightning protection system will be installed to protect the structure and associated appurtenances. Provide a UL Master Label for the system.

Design Criteria

The system will comply with NFPA 780 - Standard for the Installation of Lightning Protection Systems. The installer will be certified with the Lightning Protection Institute and the installing Contractor will provide a UL Master Label for the completed system.

Equipment and Components

Materials will be rated Class I for structure heights of 75' or less. Class II for structure heights above 75'.

Air terminals will be solid copper with a tapered point, 10" minimum height, and have a mounting base suitable for the location.

Conductors will be bare-stranded copper.

Ground rods will be copper-clad steel, 3/4" diameter by 10' long, with a bronze mechanical-type conductor clamp.

Distribution

The system layout and design will encompass all exterior surfaces of the facilities under a complete zone of protection as defined by NFPA 780. Air terminal spacing will not exceed 20 ft, except spacing up to 50 ft is allowed for non-perimeter areas of flat roofs. Locations will comply with NFPA 780 and will generally follow the building roof ridges and/or perimeters.

One (1) down conductor will be provided for every 250 ft of building perimeter, with a minimum of two (2) conductors. Conductors will be configured to provide a two-way path to earth. Metal bodies will be bonded to the conductor system in accordance with NFPA 780. All down conductors to be concealed.

A ground rod will be connected to each down conductor. Separate grounding electrodes for the lightning protection system will be installed. Once the lightning protection system and the building ground system have been completed and tested, they will be bonded together.

General Materials

Wiring

Conductors will be provided and meet the requirements of the NEC and University standards. All conductors will be copper.

Conductors for 480V through 120V circuits will be copper THWN/THHN thermoplastic insulated. Color code will follow industry standards. Each circuit will have a dedicated neutral conductor. Conductors will be solid for size #10 AWG and smaller.

Conductors will be sized to limit voltage drop to 2% for feeders and 3% for branch circuits. Minimum wire size will be #12 AWG.

Conduit

All power wiring will be installed in conduit. Minimum size will be ¾" except communications which is discussed under that section. Supports will be installed per NEC.

EMT will be utilized for general purpose locations within the building. Fittings will be compression type for ¾" to 2 ½" and double setscrew type for 3" and larger.

Rigid steel conduit will be utilized in above-grade exterior locations, in mechanical spaces, and in other areas exposed to physical damage.

Schedule 40 PVC will be used below slab and in any area necessary for corrosion resistance. No conduit will be installed within slabs.

All interior conduit will be concealed except for mechanical and other unfinished spaces where appropriate.

As required by Code, the feeders and branch circuit wiring to emergency loads (lighting, fire alarm, telecommunications, etc.) will be in dedicated raceway.

Devices

Wiring devices will be installed per NEC and University standards.

General use duplex receptacles will be 20 amperes, 125 volts.

Select receptacles in collaboration and seating areas will include type USB-C and USB-A outlets.

General use light switches will be 20 amperes, 277 volts rated or low-voltage type as necessary for the control system.

GFCI protected receptacles are used in wet locations and elsewhere as required by code. All exterior receptacles will be provided with a die-cast in-use cover.

Floor boxes and fire rated poke-thrus will be provided in conference rooms, select seating and collaboration spaces where wall power connections are not feasible. Basis of design to be FSR.

Covers for normal and emergency devices will be 304 stainless steel.

All outlet covers will be engraved with panel number and circuit number. The inside of outlet box covers will also be labeled with panel and circuit.

Emergency power devices will be red.

Fire Alarm System

A manual and automatic fire alarm system will be provided for the facility in accordance with the International Fire Code, Life Safety Code, National Fire Alarm and Signaling Code, and University standards.

The fire alarm system will be provided by Simplex Grinnell under the electrical contractor's scope of work.

The fire alarm will be a voice annunciation type and interfaced with the campus emergency notification system. The system speakers will be permitted to be used for paging and brief announcements.

The system will be activated by:

- Manual means at exits and as required by code.
- Automatic means on sprinkler water flow.
- Automatic means by smoke detection at elevator locations, control locations, smoke doors, and air handling units as required by Code.

Alarms and trouble conditions are to be transmitted to the campus central receiving station. All fire alarm cabling will be installed in a dedicated conduit system.

Mechanical Narrative

General

The following Conceptual Narrative describes Mechanical work associated with the proposed ~ 235,000 gross square foot facility located on the Health Science Campus at the University of Louisville.

Codes & Standards

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. Where code references are given, the latest issue of that code in effect at the time of bidding shall be used. Refer to the following Codes, Standards and Regulations:

- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- American Society of Heating and Refrigeration (ASHRAE)
- ARI (American Refrigeration Institute)
- National and State Electrical Code (NEC) (2023)
- National Electrical Manufacturer's Association (NEMA)
- National Fire Protection Association Codes and Standards (NFPA)
- Occupational Safety and Health Act (OSHA)
- Standards of Underwriters Laboratories (UL)
- Accessibility Requirements Code
- Environmental Protection Agency
- International Building Code (2015)
- International Existing Building Code (2015)
- International Mechanical Code (2015)
- Kentucky Building Code (KBC) (2018)
- International Energy Conservation Code (2012)
- Kentucky State Plumbing Code (KAR Title 815, Chpt. 20)
- Kentucky Existing Building Code

Design Criteria & Assumptions

The design criteria to be utilized for HVAC design, Energy Modeling and Heating/Cooling Load Calculations.

In addition to the codes listed above, codes used specifically for the HVAC design of the project are listed below. If a conflict arises between the codes, the stricter shall control.

- ASHRAE 55 - Thermal Environmental Conditions for Human Occupancy (2013)

- ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality (2010)
- ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings (2010)
- IBC - International Building Code (2015)
- IMC - International Mechanical Code (2015)

HVAC Control schemes and sequences will as a minimum meet the requirements of 2010 ASHRAE Standard 90.1, 2010, ASHRAE Standard 62.1, Energy Standard for Buildings-Except Low-Rise Residential Buildings as well as the 2012 International Energy Conservation Code.

All HVAC equipment, ductwork, piping, etc. shall be seismically braced per Kentucky Building Code and ASCE7-05. Seismic Design Category is assumed to be B at this time.

The design of HVAC systems with respect to noise and vibration control will be in accordance with ASHRAE standards. The following maximum sound levels will not be exceeded in the design or installation per the following requirements:

- Classrooms NC30-35
- Offices NC35
- Conference rooms NC25-30
- Corridors and support areas NC45

Cooling Design Conditions:

- Outdoor Air Summer Dry Bulb: 93.2°F
- Outdoor Air Summer Wet Bulb: 75.5°F
- Indoor Cooling Space Conditions: 75° F & 50% RH;
- Design RH maximum: 60% RH
- Design RH minimum: No design minimum humidity unless otherwise noted
- Mechanical/Electrical Rooms: 80° F
- Comm Rooms: 75° F

Heating Design Conditions:

- Outdoor Air Dry Bulb: 8°F
- Indoor Heating Space Conditions 70° F unless noted otherwise
- Humidity Control No positive control incorporated into the design.
- Design RH minimum: 30% RH in labs; No design minimum elsewhere

System Temperature Settings:

Occupied Areas (Need to add dead-band for changing from heating to cooling)

- Occupied Heating 68° F -72° F, Unoccupied Heating 60F
- Occupied Cooling 75° F -77° F, Unoccupied Cooling 85F (deviation from standard 72F-78F, due to IECC)

Mechanical Areas and Electrical Areas

- Heating 60° F
- Cooling 77° F
- IT Spaces Cooling only 68° F 24/7

Hours of Operation (Assumed):

- Classroom School Hours/Days: Monday thru Friday – 8 AM – 10 PM (14 hours per day)
- Spring: Jan 5 - May 1
- Summer: May 10 - July 25
- Fall: Aug 14 - Dec 16
- Scheduled classrooms unoccupied on Weekends, Holidays, Breaks between semesters
- Office Hours/Days
    - Generally in operation 8AM- 6PM (10 hours per day year around)
    - Scheduled Offices unoccupied on Weekends and Holidays

Building Pressure Testing & CO2 Levels

A Full Building Air Leakage blower door test in accordance with ASTM E 1827, Single Point Method after construction is to be completed. Air leakage through full building enclosure shall not have exceeded 0.15 cfm/sq. ft. of surface area when tested in accordance with ASTM E 1827 at a static-air-pressure difference of 0.30 in. w.g.

A Harvard Study on the relation between CO2 and cognitive function was discussed in programming meetings. The goal is to provide maximum CO2 levels of ~1,000 PPM (ABSOLUTE READING) in learning spaces. The following ventilation rates are to be utilized per each space type:

- Office/ Open Areas: Code Minimum
- Education Spaces/Conference Rooms: 30% increased ventilation (10% diversity taken-DCV to maximum of ~1,000 PPM)

HVAC Systems

Heat gain and heat loss calculations will be performed in accordance with the current edition of the ASHRAE Handbook of Fundamentals and the latest edition of the ASHRAE Cooling and Heating Load Calculation Manual. The Heating and Cooling Load calculations will be performed on a room-by-room basis. The design will comply with ASHRAE 90.1.

Actual light fixture count and heat release data will be utilized to calculate the heat dissipated by the lights into each space. Preliminary loads are based on ASHRAE 90.1 light power density allotments.

For "plug loads", the actual equipment count and rating will be utilized to determine the wattage of heat dissipation to the spaces.

Central Systems – Darcy System and 6-pipe Heat Pump Chiller

The net-zero and high-performance goals of the project and the tight, urban site prevent a traditional geothermal system from being utilized. Instead, a geothermal heat exchanger system by Darcy Solutions will be used. The system utilizes a stainless-steel and PVC heat exchanger and submersible pump located within a well in order to exchange heat with the aquifer. The building-side closed loop hydronic piping is routed underground to each well where it is connected to the heat exchanger. The submersible pump in the well conveys water across the heat exchanger to heat or cool the water in the closed loop.

Based on the test well results from a nearby project, it is expected that each well will produce 1350 MBH in cooling and 700 MBH in heating. A new test well must be performed on the site to confirm.

The building will require approximately 400 tons of cooling with 200 additional tons of capacity for redundancy/future buildings. Darcy solutions will provide all components on site, including up to 6 (6) 150ft deep wells and all associated piping, accessories, and controls back to the building. In cooling mode, the geothermal system will reject 90 deg. F condenser water from the building and receive 80 deg. F water back to the building. In heating mode, the geothermal system will reject 45 deg. F condenser water from the building, and receive 55 deg. F water back to the building.

Horizontal piping shall be HDPE fused piping at a minimum SDR of 15.5. All horizontal piping shall be a minimum of four feet below grade and the trenches under the service drive shall be 100% back filled to subgrade with compacted gravel. The piping will route to a header in the main mechanical room and tie into (6) 100-ton 6-pipe heat recovery chiller modules. Two modules are redundant. Basis of design shall be Water Furnace Tru Climate 500.

The multi-module heat pump chiller will be able to produce chilled water and hot water even in the event of a failure of one or more refrigerant circuits, minimizing building downtime during system failures. Each individual module will be able to provide, (1) full cooling capacity with zero need for

hot water, (2), full simultaneous heat recovery, providing full heating and cooling capacities, and (3) full heating capacity with zero need for chilled water.

The control system shall monitor entering and leaving chilled water and hot water temperatures to determine both the chilled water and hot water system demand. The control system will use the demand to make staging mode (cooling, heating, or simultaneous heat recovery) decisions and select the number of compressor circuits required to operate. The system shall provide for variable time between compressor sequencing and temperature sensing, so as to optimize the chiller performance to different existing building loads.

The new chilled water and hot water piping will be extended from the heat recovery chillers to chilled beams throughout each level, as well as the airside mechanical room on Level 6.

- Chilled water supply temperature shall be 42°F with a 14°F delta T.
- Hot water supply temperature shall be 120°F with a 20°F delta T.
- The system will be able to reliably produce 130°F water at 0°F Ambient.

The building will be supplied with 3 distribution loops.

- Chilled Water Loop - 42°F
- Chilled Beam Loop - 59°F
- Hot Water Loop - 120°F

Chilled Water will be provided to both DOAS units and into the return of the Chilled Beam loop to maintain Chilled Beam loop temp. The chilled water loop will be served by three (3) 350 GPM 15 hp base mounted pumps located in the main mechanical room. BOD Bell and Gossett e-1510.

The Chilled Beam loop will be distributed throughout the building to all sensible only chilled beams and fan-powered cooling boxes. The chilled beam loop will be served by three (3) 450 GPM 15 hp base mounted pumps located in the main mechanical room. BOD Bell and Gossett e-1510.

The hot loop will be distributed throughout the building to both DOAS units and all chilled beams and fan-powered cooling boxes. The hot water loop will be served by three (2) 350 GPM 10 hp base mounted pumps located in the main mechanical room. BOD Bell and Gossett e-1510.

A backup gas boiler sized for 400 MBH and 50 GPM inline pump shall serve an emergency hot water loop in the event of a power loss to maintain heating at stairwells and building entrances.

Ventilation Systems

Fresh air will be supplied to all spaces by two 25,000 CFM Dedicated Outside Air Units (DOAS) units, complete with MERV 8 prefilters, MERV 13 unit filters, energy recovery wheel, direct drive plenum fan arrays, hot water heating coil, and chilled water-cooling coil.

The dedicated outside air handling units shall be indoor type units by and shall have double wall construction. Two units shall be provided in the top level mechanical room and shall be installed on "floating floor slabs" for vibration isolation.

The DOAS units will provide dehumidifies 52°F primary air to all spaces. See plans for approx. route and sizing. The DOAS system handles all dehumidification load required in the building. The hot water coil will be based on a 120°F HWS temperature. The chilled water coil will be based on a 14°F delta T.

The fresh air will be distributed via VAV terminal boxes. A VAV box shall be provided for each ventilation zones outline on drawings. VAV boxes shall be controlled by room humidity, mounted CO2 sensors, space temperature. It is estimated there will be 200 zones.

Single wall galvanized steel duct with insulation will distribute supply air to the occupied spaces and single wall galvanized duct will collect exhaust air from the space.

Any onboard controls will have BACNET serial interface and the DOAS unit will be controlled, monitored and alarmed by the BAS.

Air Handling Unit

A new 20,000 CFM air handling unit will serve the main lobby and lower level public areas. The unit will include MERV 13 unit filters, direct drive plenum fan arrays, hot water heating coil, and chilled water-cooling coil.

The unit shall be indoor type unit shall have double wall construction. The unit shall be provided in the top level mechanical room and shall be installed on "floating floor slabs" for vibration isolation.

The AHU will provide dehumidifies 52°F primary air to all spaces. See plans for approx. route and sizing. The hot water coil will be based on a 120°F HWS temperature. The chilled water coil will be based on a 14°F delta T.

The air will be distributed via VAV terminal boxes. A VAV box shall be provided for each zone outlined on drawings. VAV boxes shall be controlled by room humidity and space temperature sensors. It is estimated that there will be 40 zones.

Single wall galvanized steel duct with insulation will distribute supply air to the occupied spaces and single wall galvanized duct will collect return air from the space.

Laboratory Air Handling Unit

It is expected that approximately 5,000 SF will be dedicated to wet lab space. A 7,500 CFM modular, double-wall type air handler will provide 53 degree Fahrenheit discharge air temperature. The mechanical room layout will include space for coil removal and fan replacement. Each coil

section will be piped with a separate shutoff valve. All units shall be located on a 4-inch concrete maintenance pad with floating floor and include vibration isolators on fans. The laboratory air handler will be variable air volume with access sections as required to properly service the unit.

The units generally will consist of (1) Outside air intake section, (2) UofL standard CUBE tri-ply filters, (3) Energy Recovery Coil w/glycol, (4) HW preheat, (5) Supply fan array with variable frequency drives, (6) Humidifier section, (7) Pre-Cooling Coil and Chilled Water Coil sized for 14 degree delta T with recirc. pump, (8) Final Filters (MERV 13- 80%-90%), (9) Air diffuser, (10) Discharge plenum.

Laboratory Air Systems

Laboratories will be provided with supply air from the lab air handling unit. The laboratory spaces contain quantities and types of chemicals that require the spaces to be exhausted direct to the outdoors. The exact quantity and location of fume hoods is to be determined. Each lab shall be maintained at a negative pressurization to the surrounding spaces. The negative pressure will be achieved through CFM offset.

The stainless steel fume hood exhaust ductwork will be connected to the galvanized duct mains and exhausted through the 5,000 CFM laboratory exhaust fan located on the roof.

Lab airflow will be controlled by Venturi style airflow control valves by Phoenix, Siemens or approved equivalent. A typical layout per lab is one exhaust airflow control valve per fume hood, one general exhaust per room (not required in chemistry labs), and one room supply airflow control valve. Each of these devices is interlocked with the fume hoods sashes, a space mounted thermostat, and a lab demand control ventilation system that is monitoring the air quality in the space. It is estimated that there will be 50 Venturi valves.

The lab air quality monitoring system and room occupancy sensor will allow the room air changes to be reduced. When the system detects no occupancy the air changed will be reduced to unoccupied. When the system detects contaminants in the air, the room airflow is increased linearly with the contaminant until the room reaches maximum air changes per hour. This process continues until the room is flushed out and the air TVOC and particulate count have returned to normal.

The fume hood exhaust ducts shall be interconnected into a common riser to lab exhaust fans with redundancy. The manifold has a total of 5,000 CFM with filtration and heat recovery coil.

Fume hood exhaust ducts will be sized for 1600-2000 feet per minute airflow. The option to size at 1200-1600 feet per minute will be used if additional capacity is to be available to convert the Physics Laboratory I the future to a wet lab.

A reduced sash height of 12" is recommend to provide a safer learning height for students, reduce energy and mechanical space requirements and for budget reduction.

The exhaust fans will be rated for chemical exhaust with a chemical resistant coating and will discharge through induction stacks with wind bands to a minimum plume height of 45 feet. The exhaust fan configuration shall maintain a pressure setpoint in the ductwork with each fan operating on a variable frequency drive. The bypass damper will control the plume height. Each fan shall include a damper to prevent the fans from rotating in reverse when not in operation. The quantity of fans shall include one redundant fan to allow for maintenance and upkeep. Motor shall be accessible without any disassembly of the fan. Fans shall have AMCA B Construction and factory installed Piezometer rings for monitoring of fan airflow and units shall be provided with weatherproof isolation bases with restrained spring isolators.

Prep rooms will have a dedicated fan coil unit to supplement the cooling requirements from freezers and coolers.

Terminal Systems

Active Chilled Beam (ACB)

The majority of space shall be provided with active chilled beam for space sensible cooling and heating loads. All chilled beam shall be 4-pipe cooling and heating. Primary air for beam shall be provide from DOAS system located in the top level mechanical space.

Fan Powered Sensible Cooing Boxes

Select spaces with high ceilings or critical ceilings shall be provided with a fan-powered sensible cooling box. Terminal unit shall be 4-pipe and provided with sensible cooling coil and hot water coil. Primary air shall be provided from DOAS system located in top level mechanical room. Refer to plans for anticipated spaces to require a sensible cooling box.

IDF/MDF

Provide a ductless wall mounted split system for each IDF/MDF space. The condensing unit shall be located on the roof.

Stair/Vestibules

Provide a recessed hydronic unit heater on the lowest level for heating only of the space.

Each stairwell and elevator shaft will be served with pressurization fans per IBC 909 and NFPA 92. Fan shall be roof mounted utility set, UL 705 listed for smoke control systems. Associated rooftop ductwork shall be provided with 2" thick mineral fiber board insulation, 6 lb-cu. Ft density, and Polyguard Alumaguard all-weather jacket with brite white finish.

Atrium

Atrium curtain wall shall be provided with baseboard hydronic heating. Atrium vestibule shall be provided with electric radiant heating panels.

Ductwork, & Accessories

All ductwork shall be galvanized steel constructed to SMACNA's standards. All ductwork joints will have a sealer applied as dictated by system duct pressure. The supply ductwork (upstream of terminal units) will need to be medium velocity, rectangular type; Run-outs to the terminal units shall be round medium pressure, spiral ductwork. The Low-Pressure ductwork (Return, exhaust, and downstream of the terminal units) will be low velocity, 2-inch pressure class. Low pressure return, exhaust and supply ductwork will be low velocity, rectangular type.

Duct locations will be coordinated with all disciplines. All duct work will be insulated to meet IECC 2006 standards. Volume control dampers will be provided at supply, return, and exhaust branch ductwork take-off locations. All supply, return, and exhaust systems will be pressure tested at specified pressure levels to ensure air leakage is minimized. Flexible duct will be insulated metallic and shall be limited to 4'-0" spans.

Grilles, Registers and Diffusers

Air distribution devices will be factory-fabricated corrosion-resistant steel or aluminum and will distribute the specified quantity of air evenly over space intended without causing noticeable drafts. All diffusers will be selected for a NC noise criteria of 20 or less, with an air pressure drop of 0.05 inches or less. Diffusers in areas where required will be selected as laminar airflow and will be laid out in a manner to reduce air recirculation and turbulence in the room.

Piping

Hydronic piping will be designed to be efficient, easily hydraulically balanced, and accessible. Valves shall be provided in accessible areas to isolate portions of systems. Piping sizes will be based on economical operation and common practice.

Hot/Chilled/Chilled Beam Water Piping

Schedule 40 black steel 125# welded or flanged joints or mechanical grooved pipe couplings and fittings with 125# rating manufactured. Valve tags and charts shall be provided for every valve 1" and larger within the facility.

Insulation

- Heating Hot Water: 1 1/2" to 2" thick fiberglass for pipes;
- Chilled/Chilled Beam water: 1 1/2" to 2" thick fiberglass for pipes;
- Supply Air and Outside Air Ductwork: 2" thick fiberglass.

Test and Balance

All HVAC air distribution and hydronic systems shall be balanced to AABC standards. All medium velocity ductwork shall be pressure tested.

Pipe and Ductwork Identification

All piping and ductwork shall be labeled every 15 feet with color coded labels. Small lamacoid equipment markers shall be installed on the "T" bar of ceiling grids to identify the location of equipment, valves, or dampers above lay-in ceilings.

HVAC Controls

Mechanical systems will be controlled by CSUSA or Siemens direct digital control (DDC) system utilizing stand-alone controllers and tied into the Campus Building Automation System. This system will be designed to provide sufficient flexibility for future modifications or expansions, as required. Controllers for the individual items of equipment will be provided with control point capacity as required for energy efficiency and control functions. All local control modules will be provide at least 10% spare points and will have battery backup and automatic memory reloading features. Mechanical systems will be controlled by DDC local control modules capable of stand-alone operation in case of the loss of communications but will normally communicate with the DDC network.

System will include detailed graphic displays, communications control between all elements of the DDC system, and application packages for energy management, facility management, power failure/automatic restart, system diagnostics and alarm monitoring and annunciation.

Zones shall be established in the design progresses and zones shall be occupied as stated above. Each zone shall be programmed independently for facilities' discrete control and programming.

Plumbing Narrative

Sanitary Sewer Service:

The building sanitary sewer will utilize a network of sanitary piping sized in accordance with the current State of Kentucky Plumbing Code and shall drain via gravity to an exterior manhole(s) and sanitary sewer system.

Mandatory cleanouts every 100' (minimum) and within 2' of utility exit for all sanitary piping shall be required.

An exterior and/or interior grease trap will be included to service food prep areas per local requirements.

Domestic Water Service:

The domestic water service shall be 4" line protected by redundant central backflow prevention equipment. A duplex pump system with VFDs and pressure tank will be installed to maintain water pressure. Domestic water will be distributed through each floor of the building, meeting local code requirements. Backflow preventer shall be located between 12" – 60" AFF.

Pressure regulating valves to be provided as required.

Domestic Water Heating System:

The domestic water heating will be provided via four (4) domestic water heat pumps, with storage tanks. The water heaters will produce 120°F-140°F domestic hot water for distribution to the entire building.

The domestic water heating systems will be fully re-circulated to maintain a minimum of 10°F temperature loss throughout the respective hot water loops.

The BMS will be utilized (via Aquastat) will be used to control & track hot water system temperatures in accordance with ASHRAE's Advanced Energy Design Guide.

Rainwater Harvesting System:

A proposed 35,000 gal cistern will be utilized to capture rainwater. This system will be used for fixture flushing, wall hydrants, and site irrigation. The building storm system will be taken to rainwater harvest tank which will then be treated/filtered to a non-potable water standard. A booster pump will bring it up to approximately 45 psig for interior use. Refer to the Resiliency and Sustainability Plan for additional information.

Roof Drainage System

A new storm sewer system will be installed to serve the building. Storm piping will be the same as the sanitary waste and vent piping. Quantity of roof drains, overflow roof drains, and site connection shall be determined during design development phase.

Natural Gas System

There is no natural gas service anticipated for this project.

Laboratory Acid Waste

The laboratories will be provided with chemical resistant waste and vent system as required. Laboratory waste and vent systems will be separate from the general use sanitary system. All concealed joints will utilize fused joints while accessible joints will utilize mechanical joints. The acid waste system will be connected to the site sanitary waste system outside the building footprint after a lab waste dilution tank. Limestone chips will be the neutralization media.

Compressed Air System

Oil-free and dried instrument grade compressed air (CA), ISO 8573.1 class 2.2.1 quality will be supplied through floor distribution piping at 100 psig to required spaces. Pressure reducing valves will be provided downstream of the laboratory point of connection for delivering laboratory compressed air (LA) at 15 – 30 psig to services.

Vacuum System

Laboratories indicated to utilize centralized vacuum system will be designed to provide 19 to 23 inch Hg negative pressure at the most remote location of vacuum service. The system will include duplex vacuum pumps, storage tank, controls, and distribution piping.

Specialty Gases

Laboratories indicated to require Specialty Laboratory Gases (CO2), (N2), (O2). Most specialty gases will be supplied from gas cylinders placed within laboratories, or gas cylinder stations located in designated areas serving adjacent laboratories. The gas cylinders may be manifolded providing redundancy and alarmed switch-over capabilities to ensure uninterrupted gas supply. Toxic, corrosive, and flammable gas cylinders will be placed in ventilated gas safety cabinets. Central distribution systems should be considered in cases of high density of services extended throughout the building.

Nitrogen and Carbon Dioxide, supplied from liquid cryogenic storage tanks located outside the building or central manifolded cylinder banks. Central systems will have redundant components or cylinder backup to ensure uninterrupted supply of gas.

Piping Materials

Plumbing Waste and Vent Piping Materials:

All above & below slab sanitary waste & vent piping shall be schedule 40 PVC piping where possible and fittings with solvent cement joints will be utilized throughout the building with the exception of the areas, where drainage temperatures may reach approx. 140°F, these areas will be provided with service weight, hubless, cast iron piping for above slab installation and service weight, hub & spigot piping for below slab installation. Any piping routed in a plenum space will utilize cast iron.

Domestic Water Piping Materials:

Underground (MAIN WATER SERVICE) -Type K Hard Copper with lead free silver solder joints. 150 lb, flanged or screwed, ball, bronze valves. No joints shall be located below slab of building.

Above ground – Type L Hard Copper with lead free silver solder joints. 150 lb, flanged or screwed, gate or ball, bronze valves.

All piping 1-1/4" & above shall be provided with brazed connections.

All above ground water piping shall be insulated per the energy code.

Insulation of water piping shall be a minimum of 1" thick with exception of 1-1/2" & larger hot water piping, which will be provided with 1-1/2" insulation.

Natural Gas Piping Materials:

All piping on the house side of the meter shall be Schedule 40 black steel piping and fittings.

Piping identification:

Pipe labels shall be provided on 25' centers. This distance shall be reduced in congested areas. Additional labels shall be provided near valves, each branch, equipment, both side of a wall, etc.

All piping in exposed mechanical/boiler rooms shall be painted and color coded.

Plumbing Fixtures

All plumbing fixtures used by students shall be vandal proof/resistant.

- Water Closets shall be wall hung, back outlet type with automatic hard wired flush valves (1.1 gpf).
- Lavatories shall be either countertop drop in or wall hung type with automatic hard wired faucet (0.5 gpm).
- Urinals shall be wall hung with automatic hard wired flush valves (0.125 gpf)
- Break room / conference room sinks shall be stainless steel countertop style with a gooseneck faucet & manual wrist blade handles.
- Drinking fountains shall be wall hung, dual height with automatic bottle filling stations
- Plumbing fixtures shall be high efficiency, water saver type where applicable.
- Freeze Proof Wall Hydrants shall be provided on 100' centers around building perimeter per the GCS Facilities Standards. Each wall hydrant shall be provided with its own isolation valves inside the building.
- All floor drains shall be provided with electronic trap primers.
- For domestic water systems, each building wing shall be provided with separate isolation valves as well as each restroom group.

Preferred vendors are as follows:

- Zurn, American Standard or Kohler for vitreous china fixtures
- Sloan or Zurn for flush valves.
- Elkay or Just Mfr. for stainless steel sinks
- Elkay, Oasis, or Halsey Taylor for drinking fountains

Fire Protection Systems

A new metered fire service line will be supplied to the building via underground supply from the local utility service. Incoming fire service shall include a post indicator valve and a double detector check valve assembly. Installation shall meet or exceed all applicable requirements of NFPA, state, and local codes.

The entire building shall be provided with a new fire suppression system designed in accordance with all applicable standards of NFPA including but not limited to NFPA 13. Piping 2" and smaller shall be schedule 40 steel pipe with threaded fittings, and 2-1/2" and larger shall be schedule 10 steel pipe with grooved type fittings.

Sprinklers shall be recessed, quick response, pendant type sprinklers in areas containing ceilings. Upright sprinklers shall be used in areas containing no ceilings, such as mechanical rooms, etc. Dry pendant/upright type sprinklers shall be utilized in the areas subject to freezing temperatures such as the loading dock and all freezer/cooler boxes. Sprinkler drain risers will be provided to allow system to be fully drained. Sprinkler drain piping shall be routed and spilled to grade or to a drain capable of handling the discharge flow.

Class I manual wet standpipes with control valve and tamper switch shall be added to each egress stairwell.

A fire hydrant flow test shall be performed to determine available static pressure, residual pressure and flow. A 1000 GPM fire pump shall be included for this project. A new flow test shall be conducted by the awarded project sprinkler contractor.

TABLE A2.1 BECx Performance Testing Requirements

Red box indicates UofL required test

NOTE 1—Areas of the table marked by leaders (". . .") indicate test methods that are not applicable.

NOTE 2—"L" indicates that a job-specific laboratory test is required.[A]

NOTE 3—"OL" indicates an optional laboratory test.

NOTE 4—"(OF)" indicates an optional field test.

NOTE 5—"(M)" indicates a laboratory pre-construction mock-up test included in or otherwise available for consideration as part of Practice E2099.

NOTE 6—"✓" indicates a mandatory field test followed by the minimum number of tests required in accordance with unique material, component, system, or assembly.

NOTE 7—"ref" indicates reference standard or guideline.

Property	Standard Designation	Title	Lab System Testing[A]	Enhanced		Fundamental	
				Field Mockup Testing[B]	In-Situ Field Testing	Field Mockup Testing[B]	In-Situ Field Testing
Acoustic Performance							
Acoustic performance	ASTM C423	Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method	OL	. . .	. . .	. . .	. . .
	ASTM E795	Practices for Mounting Test Specimens During Sound Absorption Tests	OL	. . .	. . .	. . .	. . .
	ASTM C522	Test Method for Airflow Resistance of Acoustical Materials	OL	. . .	. . .	. . .	. . .
	ASTM E492	Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine	OL	. . .	. . .	. . .	. . .
	ASTM E90	Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements	OL	. . .	. . .	. . .	. . .
	ASTM E1425	Practice for Determining the Acoustical Performance of Windows, Doors, Skylights, and Glazed Wall Systems	OL	. . .	. . .	. . .	. . .
	AAMA 1801	Voluntary Specification for the Acoustical Rating of Exterior Windows, Doors, Skylights and Glazed Wall Sections	OL	. . .	. . .	. . .	. . .
	ASTM E336	Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings	. . .	. . .	(OF)	. . .	(OF)
	ASTM E596	Test Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures	OL	. . .	. . .	. . .	. . .
	ASTM E966	Guide for Field Measurements of Airborne Sound Attenuation of Building Facades and Facade Elements	. . .	✓ (1X)	(OF)	(OF)	(OF)
	ASTM E1007	Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures	. . .	(OF)	(OF)	(OF)	(OF)
	ASTM E1014	Guide for Measurement of Outdoor A-Weighted Sound Levels	. . .	✓ (1X)	(OF)	(OF)	(OF)
	ASTM E1503	Test Method for Conducting Outdoor Sound Measurements Using a Digital Statistical Sound Analysis System	. . .	✓ (1X)	(OF)	(OF)	(OF)
	ASTM E1050	Test Method for Impedance and Absorption of Acoustical Materials Using a Tube, Two Microphones and a Digital Frequency Analysis System	OL	. . .	. . .	. . .	. . .
	ASTM E2179	Test Method for Laboratory Measurement of the Effectiveness of Floor Coverings in Reducing Impact Sound Transmission Through Concrete Floors	OL	. . .	. . .	. . .	. . .

TABLE A2.1 *Continued*

Property	Standard Designation	Title	Lab System Testing[A]	Enhanced		Fundamental	
				Field Mockup Testing[B]	In-Situ Field Testing	Field Mockup Testing[B]	In-Situ Field Testing
	ASTM E2249	Test Method for Laboratory Measurement of Airborne Transmission Loss of Building Partitions and Elements Using Sound Intensity	OL	. . .	. . .	. . .	. . .
	ANSI/ASA S12.8	Methods for Determination of Insertion Loss of Outdoor Noise Barriers	. . .	(OF)	(OF)	(OF)	(OF)
	ANSI/ASA S12.60	Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools	OL	. . .	. . .	. . .	. . .
		Air Infiltration					
Air flow	ASTM E2319	Test Method for Determining Air Flow Through the Face and Sides of Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen	OL	. . .	. . .	. . .	. . .
Air leakage	ASTM E283	Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen	L (M)	. . .	. . .	. . .	. . .
	ASTM E779[C]	Test Method for Determining Air Leakage Rate by Fan Pressurization	. . .	. . .	✓ (1X)[C]	. . .	(OF)
	ASTM E1827[C]	Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door	. . .	. . .	✓ (1X)[C]	. . .	(OF)
	ASTM E783[D] *Opaque Walls*	Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors	. . .	✓ (1X)	✓ (1X)	✓ (1X)	✓ (1X)
	ASTM E783[E] *Windows*	Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors	. . .	✓ (1X)	✓ (2X)	✓ (1X)	✓ (1X)
	ASTM E1186[F]	Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems	. . .	(OF)	✓ (1X)	(OF)	✓ (1X)
Air permeance	ASTM E2178	Test Method for Air Permeance of Building Materials	OL	. . .	. . .	. . .	. . .
	ASTM E2357	Test Method for Determining Air Leakage of Air Barrier Assemblies	OL	. . .	. . .	. . .	. . .
		Thermal Performance and Condensation Resistance					
Condensation resistance	AAMA 1503	Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors, and Glazed Wall Sections	OL[G] (M)	(OF)[H]	(OF)	(OF)	(OF)
Insulation	ASTM C1153	Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging	. . .	. . .	✓ (1X)[I]	. . .	✓ (1X)[I]
Temperature index calculation/test	AAMA 501.5	Test Method for Thermal Cycling of Exterior Walls	OL (M)	(OF)	. . .	(OF)	. . .
Thermal performance	CAN/CGSB 149-GP-2MP	Manual for Thermographic Analysis of Building Enclosures	ref	. . .	. . .	. . .	. . .
Insulation	ASTM C1060	Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings	. . .	. . .	(OF)	. . .	(OF)
Dew point of IGU	ASTM E576	Test Method for Frost/Dew Point of Sealed Insulating Glass Units in the Vertical Position	. . .	(OF)	(OF)	(OF)	(OF)
Heat Loss	ANSI/ASHRAE/IES Standard 101	Application of Infrared Sensing Devices to the Assessment of Building Heat Loss Characteristics	. . .	(OF)	(OF)	(OF)	(OF)
U factor	NFRC 100	Procedure for Determining Fenestration Product U-Factors	OL	. . .	. . .	. . .	. . .
	ASTM E2264	Practice for Determining the Effects of Temperature Cycling on Fenestration Products	OL	. . .	. . .	. . .	. . .

TABLE A2.1 *Continued*

Property	Standard Designation	Title	Lab System Testing[A]	Enhanced		Fundamental	
				Field Mockup Testing[B]	In-Situ Field Testing	Field Mockup Testing[B]	In-Situ Field Testing
		Water Penetration					
Water penetration	ASTM E331	Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference	L (M)	. . .	. . .	. . .	. . .
	ASTM E514/E514M	Test Method for Water Penetration and Leakage Through Masonry	OL	(OF)	(OF)	(OF)	(OF)
	ASTM C1601	Test Method for Field Determination of Water Penetration of Masonry Wall Surfaces	. . .	(OF)	(OF)	(OF)	(OF)
	ASTM D5957[J]	Guide for Flood Testing Horizontal Waterproofing Installations	. . .	(OF)	✓ (All horizontal surfaces)	(OF)	✓ (All horizontal surfaces)
Static water penetration	ASTM E1105	Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference	. . .	✓ (1X)	✓ (2X)	✓ (1X)	✓ (1X)
Dynamic water penetration	AAMA 501.1	Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure	OL (M)	(OF)	✓ (1X)	(OF)	(OF)
	ASTM E2268[K]	Test Method for Water Penetration of Exterior Windows, Skylights, and Doors by Rapid Pulsed Air Pressure Difference	OL	(OF)	(OF)	(OF)	(OF)
	AAMA 501.2	Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems	. . .	✓ (1X)	✓ (1X)	✓ (1X)	✓ (1X)
		Durability and Appearance					
Glazing stress testing	ASTM C1279	Test Method for Non-Destructive Photoelastic Measurement of Edge and Surface Stresses in Annealed, Heat-Strengthened, and Fully-Tempered Flat Glass	OL	. . .	. . .	. . .	. . .
Glazing structural performance	ASTM E997	Test Method for Evaluating Glass Breakage Probability Under the Influence of Uniform Static Loads by Proof Load Testing	OL	(OF)	. . .	(OF)	. . .
	GANA LD 100-06	Standard Test Method for Ball Drop Impact of Laminated Architectural Flat Glass	OL	. . .	. . .	. . .	. . .
	GANA LD 101-08	Standard Specification for Ball Drop Impact Resistance of Laminated Architectural Flat Glazing	OL	. . .	. . .	. . .	. . .
	GANA TD 101-04	Standard Test Method for Center-Punch Fragmentation of Fully-Tempered Flat Glass	OL	. . .	. . .	. . .	. . .
Glazing material appearance and durability	ASTM C724	Test Method for Acid Resistance of Ceramic Decorations on Architectural-Type Glass	OL	(OF)	. . .	(OF)	. . .
	ASTM C1651	Test Method for Measurement of Roll Wave Optical Distortion in Heat-Treated Flat Glass	OL	(OF)	(OF)	(OF)	(OF)
	ASTM C1652/C1652M	Test Method for Measuring Optical Distortion in Flat Glass Products Using Digital Photography of Grids	OL	(OF)	(OF)	(OF)	(OF)
	ASTM E2649	Test Method for Determining Argon Concentration in Sealed Insulating Glass Units Using Spark Emission Spectroscopy	OL	. . .	. . .	. . .	. . .
Adhesion and durability	ASTM C1258	Test Method for Elevated Temperature and Humidity Resistance of Vapor Retarders for Insulation	OL	. . .	. . .	. . .	. . .
	ASTM C1522	Test Method for Extensibility After Heat Aging of Cold Liquid-Applied Elastomeric Waterproofing Membranes	OL	. . .	. . .	. . .	. . .
	ASTM D4541	Test Method for Pull-off Strength of Coatings Using Portable Adhesion Testers	. . .	✓ (1X)	✓ (1X)	✓ (1X)	(OF)

TABLE A2.1 *Continued*

Property	Standard Designation	Title	Lab System Testing[A]	Enhanced		Fundamental	
				Field Mockup Testing[B]	In-Situ Field Testing	Field Mockup Testing[B]	In-Situ Field Testing
	ASTM E488/ E488M	Test Methods for Strength of Anchors in Concrete Elements	. . .	(OF)	✓ (1X)	✓ (1X)	✓ (1X)
	ASTM E2359/ E2359M	Test Method for Field Pull Testing of an In-Place Exterior Insulation and Finish System Clad Wall Assembly	. . .	✓ (1X)	✓ (1X)	✓ (1X)	✓ (1X)
	ASTM E2570/ E2570M	Test Methods for Evaluating Water-Resistive Barrier (WRB) Coatings Used under Exterior Insulation and Finish Systems (EIFS) or EIFS with Drainage	OL	. . .	. . .	. . .	. . .
Sealant durability[L]	ASTM C794	Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants	OL	✓ (1X)	✓ (3X)	✓ (1X)	✓ (1X)
	ASTM C732	Test Method for Aging Effects of Artificial Weathering on Latex Sealants	OL	. . .	. . .	. . .	. . .
	ASTM C1087	Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems	OL	. . .	. . .	. . .	. . .
	ASTM C1193-11a, Appendix X1-Method A	Guide for Use of Joint Sealants: Field-Applied Sealant Joint Hand Pull Tab	. . .	✓ (1X)	✓ (1X)	✓ (1X)	✓ (1X)
	ASTM C1246	Test Method for Effects of Heat Aging on Weight Loss, Cracking, and Chalking of Elastomeric Sealants After Cure	OL	. . .	. . .	. . .	. . .
	ASTM C1294	Test Method for Compatibility of Insulating Glass Edge Sealants with Liquid-Applied Glazing Materials	OL	. . .	. . .	. . .	. . .
Sealant appearance	ASTM C510	Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants	OL	. . .	. . .	. . .	. . .
	ASTM D2203	Test Method for Staining from Sealants	OL	. . .	. . .	. . .	. . .
		Structural Performance					
Envelope deflection due to wind loading	ASTM E330/ E330M	Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference	L (M)	(OF)	(OF)	(OF)	(OF)
Inter-story drift	AAMA 501.4	Recommended Static Test Method for Evaluating Window Wall, Curtain Wall and Storefront Systems Subjected to Seismic and Wind-Induced Inter-Story Drift	OL (M)	. . .	. . .	. . .	. . .
Wind uplift	CSA-A123.21	Standard Test Method for the Dynamic Wind Uplift Resistance of Membrane-Roofing Systems	OL	(OF)	(OF)	(OF)	(OF)
		Rain Screen Pressure Equalization					
	AAMA 508-07	Voluntary Test Method and Specification for Pressure Equalized Rain Screen Wall Cladding Systems	L	(OF)	. . .	(OF)	. . .
		Solar Optical Performance					
Solar Absorptance	ASTM E903	Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres	OL	(OF)	(OF)	(OF)	(OF)
	NFRC 200	Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence	OL	. . .	. . .	. . .	. . .
Solar optical properties	NFRC 300	Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems	OL	. . .	. . .	. . .	. . .
	ASTM C1371	Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers	OL	(OF)	(OF)	(OF)	(OF)
	ASTM C1549	Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer	OL	(OF)	(OF)	(OF)	(OF)
	ASTM E1980	Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces	OL	. . .	. . .	. . .	. . .

TABLE A2.1 *Continued*

Property	Standard Designation	Title	Lab System Testing[A]	Enhanced		Fundamental	
				Field Mockup Testing[B]	In-Situ Field Testing	Field Mockup Testing[B]	In-Situ Field Testing
		Moisture Content					
Moisture content	ASTM F1869	Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride	OL	(OF)	(OF)	(OF)	(OF)
	ASTM F2170	Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes	OL	(OF)	(OF)	(OF)	(OF)
	ASTM F2420	Test Method for Determining Relative Humidity on the Surface of Concrete Floor Slabs Using Relative Humidity Probe Measurement and Insulated Hood (Withdrawn 2014)	OL	(OF)	(OF)	(OF)	(OF)
		Security					
Forced entry	ASTM F1233	Test Method for Security Glazing Materials and Systems	OL	(OF)	(OF)	(OF)	(OF)
	SD-STD-01.01	Forced Entry and Ballistic Resistance of Structural Systems	OL	(OF)	(OF)	(OF)	(OF)
Impact/ballistic resistance	ASTM E1886	Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials	OL	. . .	. . .	. . .	. . .
	ASTM E2353	Test Methods for Performance of Glazing in Permanent Railing Systems, Guards, and Balustrades	OL	. . .	. . .	. . .	. . .
	ASTM E1996	Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes	OL	. . .	. . .	. . .	. . .
	CEN 1063	Testing and Classification of Resistance Against Bullet Attack	OL	. . .	. . .	. . .	. . .
	NIJ Std. 0108.01	Ballistic Resistant Protective Materials	OL	. . .	. . .	. . .	. . .
	UL 752	Standard for Bullet-Resisting Equipment	OL	. . .	. . .	. . .	. . .
Blast	ASTM F1642/F1642M	Test Method for Glazing and Glazing Systems Subject to Airblast Loadings	OL	. . .	. . .	. . .	. . .
	GSA-TS01	Standard Test Method for Glazing and Window Systems Subject to Dynamic Overpressure Loadings	OL	. . .	. . .	. . .	. . .

[A] Applies to both Fundamental and Enhanced if laboratory testing is performed: Note laboratory mock-ups are NOT a requirement of either fundamental or enhanced BECx.
[B] Including both off-building and "first installation" on-building mockups.
[C] Specifier has the option to perform one, or both, of these tests (Test Method E779 and/or Test Methods E1827) to confirm whole building air leakage rates. Alternatively, in lieu of whole building air testing, the BECxP may increase the number of Test Method E783 tests or Practices E1186 for the various wall components and systems to a number deemed representative of the enclosure.
[D] Typically performed in conjunction with Practices E1186.
[E] Typically performed in conjunction with Test Method E1105.
[F] A qualitative test typically performed in conjunction with Test Method E783 at opaque walls.
[G] A job-specific laboratory test may be recommended by the BECxP based on climate and enclosure designs with increased condensation risk (that is, thermal bridges across the enclosure including curtain walls incorporating fins or structural elements that extend through the thermal barrier).
[H] A modified AAMA 1503 test may be performed in the field.
[I] As required in conjunction with required water penetration resistance testing of roofing and as appropriate for specific roofing assembly.
[J] Depending upon roofing type and installation, Electronic Weak Detection (ELD) or Nuclear Radioisotopic Thermalization may also be considered to supplement or replace this evaluation.
[K] This test serves as an alternate to the Field Dynamic testing as listed in AAMA 501.1. The number of tests recommended do not align (are less then) AAMA 501.1 as this practice requires construction of a chamber to provide a differential pressure.
[L] Note: peel adhesion tests are often performed by sealant manufacturers as part of their warranty requirements. BECxP shall determine if the manufacturer's tests satisfy the requirements of this practice.

A2.6 Pre-construction laboratory mock-up testing shall be completed in accordance with Practice E2099, modified as required to respond to the performance objectives established in the OPR and BOD and included in the construction contract documents by the AOR, in consultation with the BECxP/BECxG and subject to review and approval by the Owner. Test standards and methodology, minimum required performance thresholds, and clearly defined definitions of "failure" must be