ADDENDUM NO. 1

Date: August 26, 2019

To: Edifice, Inc., Construction Manager

From: **Jenkins•Peer** *Architects*
Charlotte, N.C.

Re: UNC Charlotte – Residence Hall Phase XVI
SCO ID: 18-18333-02A
JPA Project #: 18NCC016

NOTICE to BIDDERS:
Bidder is hereby notified that this Addendum shall hereby become a part of the Construction Documents and the official Contract Documents, and shall be attached to the Project Manual for the Project.

The following items are intended to revise and clarify the Drawings and the Project Manual.

The construction manager shall see that their 1st tier Bidders are in full receipt of the information contained herein and these Bidders shall see that Sub-Bidders also receive the information.

General Note:
This Addendum includes the following groups and subsequent "items" referring to various parts of the Contract Documents. Note that some "items" may refer to Bulletin Drawings or new Specification Sections which are attached at the back of the Addendum.

GENERAL REQUIREMENTS

No revisions to General Requirements

PROJECT MANUAL & TECHNICAL SPECIFICATIONS DIVISIONS

Item 1. 23 05 93 – TESTING, ADJUSTING, AND BALANCING FOR HVAC: Removed unused section references
Item 2. 23 07 00 – HVAC INSULATION: Requirement revision due to RFI
Item 3. 23 09 00 – INSTRUMENTATION AND CONTROL FOR HVAC: Revision to acceptable control vendors

DRAWING SHEETS:

Item 4. C-1.01: Clarification of finished grade
Item 5. C-3.00: Revision of site wall construction to CMU from CIP
Item 6. C-7.06: Revision of site wall construction to CMU from CIP
Item 7. S-801: Revision of site wall construction to CMU from CIP
Item 8. A-111: Revised drainage from east and south bay roofs.
Item 9. A-310: Revised drainage from east and south bay roofs.
Item 10. A-312: Revised drainage from east and south bay roofs.

Item 11. A-510: Revision of site wall construction to CMU from CIP
Item 12. A-557: Revised drainage from east and south bay roofs.
Item 13. A-706: Remove line and tag at COR007; Remove material TW from Specialty Finish Legend
Item 14. A-707: Remove line and tag at COR108; Remove material TW from Specialty Finish Legend
Item 15. A-708: Remove line and tag at COR208; Remove material TW from Specialty Finish Legend
Item 16. A-709: Remove detail 1/A-709 in its entirety
Item 17. M-001: Revision to acceptable control vendors
Item 18. E-100: Background graphics revised.
Item 19. E-101: Clarified two existing light poles that are to be removed during construction and replaced in place. Background graphics revised.

RFI RESPONSES:

Item 20. *Q1: Did the current design implement UNCC's ILM implementation plan?*
Response: Yes. UNC Charlotte ILM requirements are referenced in multiple sheet locations and by specification section 01 78 23 – DIGITAL MANAGEMENT EXCHANGE GUIDELINES (DMEG)

Item 21. *Q2: Project manual section 01 23 00 section 1.4 Alternates, Item N. Confirm that all window sills in the base bid are to be drywall return. Does this also apply to window sills that are specifically called out in the plans as cultured marble or wood (example C4/A-541)?*
Response: All windows are to have drywall return except those indicated to have wood.

Item 22. *Q3: In the typical 2BD Double rooms, is the alternate for cultured marble window sills to include the entire low wall sill denoted as "drywall return win. sill" as shown in C1/A-408 or just the sill at the actual window?*
Response: The intent is to have all the low wall sill of the room as drywall as base bid. And the same low wall sill of the room as alternate.

Item 23. *Q4: A4/A-543 notes the back of the wall at the island as solid surface, but A5/A-543 notes the back of the wall as PL-1. Please confirm that PL-1 is correct for the back of the island walls.*
Response: PL-1 is the correct designation for detail A4 back of the island

Item 24. *Q5: D3,D4/A-401 - Confirm wall mounted shelving in this area will be installed with surface mounted brackets & support system.*
Response: Shelving is to be installed with surface mounted brackets and support system.

Item 25. *Q6: Project manual section 01 23 00 section 1.4 Alternates, Item F appears to note all public restroom tops are to be plastic laminate in the base bid, yet section C4/A-543 calls them out as CM-1. Confirm that plastic laminate is correct for the base bid.*
Response: Refer to detail C5/A-543 for the base bid condition.

Item 26. *Q7: Is the solid surface material for the above alternate (item F) to be CM-1 or a Corian type solid surface material with integral bowl?*
Response: Alternate is to be CM-1

Item 27. *Q10: Typical details on A3 and A2/A-311, show the 3 row pattern for pad style snow guards. Will these be required at all eaves of the shingle roof?*
Response: The required extents and configuration of snow guards are indicated on sheet A-111.

Item 28. *Q12: Please provide a complete toilet and bath accessory schedule with detailed specifications.*
Response: The schedule of toilet accessories is located on sheet A-407, along with OFCI and CFCI requirements.

Item 29. *Q13: On A406 and other places, both walls and doors are highlighted as partitions. Please confirm that the intent was that all shower doors (not side walls) are to be partition doors/pilasters or clarify exactly what components are to be ordered as partitions in shower areas.*
Response: Shower dividers are actual walls. Shower partitions are only to receive the doors.

Item 30. *Q14: Detail C3 points out TA10 and other places note that showers come with grab bars. Please confirm that TA10 highlighted in showers is CFCI.*
Response: Per Toilet Accessories Schedule, TA-10 is CFCI

Item 31. *Q15: Please provide size of TA10 in Detail A5, C3 adn D4(A407) if it is to be included as CFCI.*
Response: Refer to ADA shower-Accessible information on sheet G-400

Item 32. *Q16: Towel dispensers, waste receptacles, sanitary napkin disposal and shelf/hook strip could not be located. Please advise on locations.*
Response: The schedule of toilet accessories is located on sheet A-407, along with OFCI and CFCI requirements.

Item 33. *Q17: Please provide the size of TA-10 in 2nd bath in A165 apartment on A404.*
Response: Refer to sheet G-400 for this information.

Item 34. *Q18: Is there intended to be tile behind the mirrors? Example E5/A-4040.*
Response: Tile shall be installed behind the mirrors.

Item 35. *Q19: Is there intended to be tile behind oven/range and refrigerator? See example C3 and C4 on A-404.*
Response: Tile backsplash is only intended to be installed in visible areas.

Item 36. *Q20: Are all three sides of the single vanities to be tiled (see D1/A-407 for an example)?*
Response: All 3 sides are tile, refer to sheets A706, 707 and 708 for specialty finish sheets for extent of tile T5 in the walls

Item 37. *Q21: There do not appear to be any depressions for these prefabricated shower pans. The ADA showers may require a depression to allow for the zero-entry threshold. What is required?* Response: The specified shower pan system and detailing are intended to not require a slab depression (ref: C1/A-406). ADA-compliant thresholds and slopes are required at all accessible transfer-type and roll in-type showers.

Item 38. *Q22: The hard tile SOW states complete coverage of WFG in 'wet areas.' Please clarify if wet areas refer to bathroom floor tile only or does this term encompass other areas?*
Response: Per specification 09 30 00, sections 2.4-H, 2.4-I, and 2.4-K, waterproofing shall be provided with tile installations in the apartment bathrooms. Antifracture membrane shall be provided at all other tile installations.

Item 39. *Q23: Public restrooms in classroom corridor 051,052,053 are not listed as tile on the specialty finishes page; however, 053 is listed on the finish schedule as having tile base and tile floor. 051 and 052 are listed as SVT but on the finish plan (A-700-S) these restrooms are depicted with tile. I have kept these rooms consistent with finish plan and have*

included all three with tile floors and base with NO tie at 'vanity' as no vanity is indicated an no elevations are provided. Is this correct?
Response: This is correct.

Item 40. *Q24: STR 04 was originally indicated as porcelain tile treads, the previous drawing release and this release indicate in the Finish Schedule (A-621 and A-622) that these stairs are now Rubber treads. The elevations (A-402 and the ornamental stairs spec section 057113 have not been changed and indicate a porcelain tread/riser at this stair. Please confirm if this is still correct?*
Response: It is correct, STR04 shall receive tile T-1 finish.

Item 41. *Q25: What is the finish in the elevators, it is not listed in the finish schedule? I am assuming it is to match the elevator lobby, which is LVT, is this correct?*
Response: Correct, the finish is to match LVT in the elevator lobby.

Item 42. *Q26: Specs and plans refer to A-604 for sign types and schedule. Is there a defined sign schedule as suggested to in plans and specs?*
Response: The signage schedule is located on sheet A-624. This scheduled will be revised to be more comprehensive as part of a following Addendum.

Item 43. *Q27: Is the addition of wall graphics on page A-709(attached) in the signage scope?*
Response: The wall graphics on A-709 are intended to be stenciled paint.

Item 44. *Q28: Referencing the exposed duct in mechanical rooms…the spec calls for flexible blanket on all insulated duct. The spec also calls for 8 oz. canvas as the finish in mechanical rooms. The industry standard is to install rigid board insulation when canvas is used as the finish. I am asking for clarification as to whether it is the intention to install canvas over flexible duct wrap, delete the canvas all together, or change the insulation in mechanical rooms the rigid fiberglass board insulation?*
Response: See revised specification requiring rigid fiber board on mechanical room exposed insulation wrapped with canvas.

Item 45. *Q29: TAB spec (230593-1, paragraph 1.2 "Summary" A6 & A7) indicates sound tests and indoor-air quality tests, however, there is no criteria listed within the specs for this testing. Please clarify requirements if these tests will be required.*
Response: The above noted section references have been removed and are not required

End of ADDENDUM NO. 1

Attachments:

- Revised Specification Sections as noted above
- Revised Drawing Sheets as noted above

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes TAB to produce design objectives for the following:
   1. Air Systems:
      a. Constant-volume air systems.
      b. Fan Coil systems.
   2. Hydronic Piping Systems:
      a. Constant-flow systems.
      b. Variable-flow systems.
   3. HVAC equipment quantitative-performance settings.
   4. Space pressurization testing and adjusting.
   5. Vibration measuring.
   6. Verifying that automatic control devices are functioning properly.
   7. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

M. TAB: Testing, adjusting, and balancing.

N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

O. Test: A procedure to determine quantitative performance of systems or equipment.

P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

C. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

D. Sample Report Forms: Submit two sets of sample TAB report forms.

E. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC or NEBB.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
   a. Submittal distribution requirements.
   b. The Contract Documents examination report.
   c. TAB plan.
   d. Work schedule and Project-site access requirements.
   e. Coordination and cooperation of trades and subcontractors.
   f. Coordination of documentation and communication flow.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
   1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

G. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2007, Section 7.2.2 - "Air Balancing."

H. ASHRAE/IESNA 90.1-2007 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6.7.2.3 - "System Balancing."

1.6 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.7 WARRANTY

A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
   1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
   2. Systems are balanced to optimum performance capabilities within design and installation limits.

B. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
   1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
   2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
   1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
   2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 01 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under

conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

M. Examine strainers for clean screens and proper perforations.

N. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

P. Examine system pumps to ensure absence of entrained air in the suction piping.

Q. Examine equipment for installation and for properly operating safety interlocks and controls.

R. Examine automatic temperature system components to verify the following:
   1. Dampers, valves, and other controlled devices are operated by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.
   3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
   4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
   5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
   6. Sensors are located to sense only the intended conditions.
   7. Sequence of operation for control modes is according to the Contract Documents.

8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

S. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:
1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
1. Comply with requirements in ASHRAE 62.1-2007, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling unit components.

L. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure fan static pressures to determine actual static pressure as follows:
      a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
      b. Measure static pressure directly at the fan outlet or through the flexible connection.
      c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
      d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
   2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
      a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
   3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
   4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
   5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
   1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
      a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
   2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.
   1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
   1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
   2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Variable air volume air handling units shall be balanced in all modes of operation: minimum airflow, maximum airflow, minimum and maximum ventilation air flow at minimum and maximum air flows and economizer (if required).

B. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

C. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
   1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
   2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
   3. Measure total system airflow. Adjust to within indicated airflow.

4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record the final fan performance data.

D. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Balance systems similar to constant-volume air systems.
2. Set terminal units and supply fan at full-airflow condition.
3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
4. Readjust fan airflow for final maximum readings.
5. Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.
6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
    a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

E. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
3. Set terminal units at full-airflow condition.
4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Adjust terminal units for minimum airflow.

6. Measure static pressure at the sensor.
7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.7 PROCEDURES FOR FAN COIL SYSTEMS

A. Balance supply airflow by measuring at main supply duct traverse point, and summation of all associated supply grilles. Balance airflow by adjusting output of unit controller from ECM motor to provide scheduled airflow within specified tolerances.

B. Coil flows shall be verified to be in applicable pressure range of associated auto flow control device

C. Adjust each fan coil unit.

3.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.9 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.10 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

B. Balance the primary system crossover flow first, then balance the secondary system.

3.11 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.12 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.13 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:
1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Refrigerant Coils: Measure the following data for each coil:
1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.14 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.15 PROCEDURES FOR SPACE PRESSURIZATION MEASUREMENTS AND ADJUSTMENTS

A. Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed and applicable safing, gaskets, and

sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.

B. Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the supply, return, and exhaust airflows to achieve the indicated conditions.

C. Measure space pressure differential where pressure is used as the design criteria, and measure airflow differential where differential airflow is used as the design criteria for space pressurization.
   1. For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.
   2. For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
   3. Test room pressurization first, then zones, and finish with building pressurization.

D. To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust and return airflow to achieve the indicated pressure or airflow difference.

E. For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.
   1. Compare the values of the measurements taken to the measured values of the control system instruments and report findings.
   2. Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test overpressurization and underpressurization and observe and report on the system's ability to revert to the set point.
   3. For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.

F. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.

G. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

3.16 PROCEDURES FOR VIBRATION MEASUREMENTS

A. Use a vibration meter meeting the following criteria:
   1. Solid-state circuitry with a piezoelectric accelerometer.
   2. Velocity range of 0.1 to 10 inches per second.
   3. Displacement range of 1 to 100 mils.
   4. Frequency range of at least 0 to 1000 Hz.
   5. Capable of filtering unwanted frequencies.

B. Calibrate the vibration meter before each day of testing.
   1. Use a calibrator provided with the vibration meter.
   2. Follow vibration meter and calibrator manufacturer's calibration procedures.

C. Perform vibration measurements when other building and outdoor vibration sources are at a minimum level and will not influence measurements of equipment being tested.
   1. Turn off equipment in the building that might interfere with testing.
   2. Clear the space of people.

D. Perform vibration measurements after air and water balancing and equipment testing is complete.

E. Clean equipment surfaces in contact with the vibration transducer.

F. Position the vibration transducer according to manufacturer's written instructions and to avoid interference with the operation of the equipment being tested.

G. Measure and record vibration on rotating equipment over 3 hp.

H. Measure and record equipment vibration, bearing vibration, equipment base vibration, and building structure vibration. Record velocity and displacement readings in the horizontal, vertical, and axial planes.
   1. Pumps:
      a. Pump Bearing: Drive end and opposite end.
      b. Motor Bearing: Drive end and opposite end.
      c. Pump Base: Top and side.
      d. Building: Floor.
      e. Piping: To and from the pump after flexible connections.
   2. Fans and HVAC Equipment with Fans:
      a. Fan Bearing: Drive end and opposite end.
      b. Motor Bearing: Drive end and opposite end.
      c. Equipment Casing: Top and side.
      d. Equipment Base: Top and side.
      e. Building: Floor.
      f. Ductwork: To and from equipment after flexible connections.
      g. Piping: To and from equipment after flexible connections.
   3. HVAC Equipment with Compressors:
      a. Compressor Bearing: Drive end and opposite end.
      b. Motor Bearing: Drive end and opposite end.
      c. Equipment Casing: Top and side.
      d. Equipment Base: Top and side.
      e. Building: Floor.
      f. Piping: To and from equipment after flexible connections.

I. For equipment with vibration isolation, take floor measurements with the vibration isolation blocked solid to the floor and with the vibration isolation floating. Calculate and report the differences.

J. Inspect, measure, and record vibration isolation.
   1. Verify that vibration isolation is installed in the required locations.
   2. Verify that installation is level and plumb.
   3. Verify that isolators are properly anchored.
   4. For spring isolators, measure the compressed spring height, the spring OD, and the travel-to-solid distance.

5. Measure the operating clearance between each inertia base and the floor or concrete base below. Verify that there is unobstructed clearance between the bottom of the inertia base and the floor.

3.17 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

J. Note operation of electric actuators using spring return for proper fail-safe operations.

3.18 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Minus 5 to plus 10 percent.
2. Air Outlets and Inlets: 0 to minus 10 percent.
3. Heating-Water Flow Rate: 0 to minus 10 percent.
4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.19 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems

found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.20 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
   1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
   1. Title page.
   2. Name and address of TAB firm.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   8. Report date.
   9. Signature of TAB firm who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents including the following:
      a. Indicated versus final performance.
      b. Notable characteristics of systems.
      c. Description of system operation sequence if it varies from the Contract Documents.
   12. Nomenclature sheets for each item of equipment.
   13. Data for terminal units, including manufacturer, type size, and fittings.
   14. Notes to explain why certain final data in the body of reports varies from indicated values.
   15. Test conditions for fans and pump performance forms including the following:
      a. Settings for outside-, return-, and exhaust-air dampers.
      b. Conditions of filters.
      c. Cooling coil, wet- and dry-bulb conditions.
      d. Face and bypass damper settings at coils.
      e. Fan drive settings including settings and percentage of maximum pitch diameter.
      f. Inlet vane settings for variable-air-volume systems.
      g. Settings for supply-air, static-pressure controller.

h. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outside, supply, return, and exhaust airflows.
2. Water flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data: Include the following:
a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
j. Number of belts, make, and size.
k. Number of filters, type, and size.
2. Motor Data:
a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Preheat coil static-pressure differential in inches wg.
g. Cooling coil static-pressure differential in inches wg.
h. Heating coil static-pressure differential in inches wg.
i. Outside airflow in cfm.
j. Return airflow in cfm.
k. Outside-air damper position.
l. Return-air damper position.
m. Vortex damper position.

G. Apparatus-Coil Test Reports:
1. Coil Data:
a. System identification.
b. Location.

c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft.
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):
a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outside-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:
a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
   1. Report Data:
      a. System and air-handling unit number.
      b. Location and zone.
      c. Traverse air temperature in deg F.
      d. Duct static pressure in inches wg.
      e. Duct size in inches.
      f. Duct area in sq. ft.
      g. Indicated airflow rate in cfm.
      h. Indicated velocity in fpm.
      i. Actual airflow rate in cfm.
      j. Actual average velocity in fpm.
      k. Barometric pressure in psig.

J. Fan Coil / Air-Terminal-Device Reports:
   1. Unit Data:
      a. System and air-handling unit identification.
      b. Location and zone.
      c. Test apparatus used.
      d. Area served.
      e. Air-terminal-device make.
      f. Air-terminal-device number from system diagram.
      g. Air-terminal-device type and model number.
      h. Air-terminal-device size.
      i. Air-terminal-device effective area in sq. ft.
   2. Test Data (Indicated and Actual Values):
      a. Airflow rate in cfm.
      b. Air velocity in fpm.
      c. Preliminary airflow rate as needed in cfm.
      d. Preliminary velocity as needed in fpm.
      e. Final airflow rate in cfm.
      f. Final velocity in fpm.
      g. Space temperature in deg F.

K. System-Coil Reports: For reheat coils and water coils of fan coil units, include the following:
   1. Unit Data:
      a. System and air-handling unit identification.
      b. Location and zone.
      c. Room or riser served.
      d. Coil make and size.
      e. Flowmeter type.
   2. Test Data (Indicated and Actual Values):
      a. Airflow rate in cfm.
      b. Entering-water temperature in deg F.
      c. Leaving-water temperature in deg F.
      d. Water pressure drop in feet of head or psig.
      e. Entering-air temperature in deg F.
      f. Leaving-air temperature in deg F.

L. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Unit make and model number.
      d. Compressor make.
      e. Compressor model and serial numbers.
      f. Refrigerant weight in lb.
      g. Low ambient temperature cutoff in deg F.
   2. Test Data (Indicated and Actual Values):
      a. Inlet-duct static pressure in inches wg.
      b. Outlet-duct static pressure in inches wg.
      c. Entering-air, dry-bulb temperature in deg F.
      d. Leaving-air, dry-bulb temperature in deg F.
      e. Condenser entering-water temperature in deg F.
      f. Condenser leaving-water temperature in deg F.
      g. Condenser-water temperature differential in deg F.
      h. Condenser entering-water pressure in feet of head or psig.
      i. Condenser leaving-water pressure in feet of head or psig.
      j. Condenser-water pressure differential in feet of head or psig.
      k. Control settings.
      l. Unloader set points.
      m. Low-pressure-cutout set point in psig.
      n. High-pressure-cutout set point in psig.
      o. Suction pressure in psig.
      p. Suction temperature in deg F.
      q. Condenser refrigerant pressure in psig.
      r. Condenser refrigerant temperature in deg F.
      s. Oil pressure in psig.
      t. Oil temperature in deg F.
      u. Voltage at each connection.
      v. Amperage for each phase.
      w. Kilowatt input.
      x. Crankcase heater kilowatt.
      y. Number of fans.
      z. Condenser fan rpm.
      aa. Condenser fan airflow rate in cfm.
      bb. Condenser fan motor make, frame size, rpm, and horsepower.
      cc. Condenser fan motor voltage at each connection.
      dd. Condenser fan motor amperage for each phase.

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Service.
      d. Make and size.
      e. Model and serial numbers.

f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):
   a. Static head in feet of head or psig.
   b. Pump shutoff pressure in feet of head or psig.
   c. Actual impeller size in inches.
   d. Full-open flow rate in gpm.
   e. Full-open pressure in feet of head or psig.
   f. Final discharge pressure in feet of head or psig.
   g. Final suction pressure in feet of head or psig.
   h. Final total pressure in feet of head or psig.
   i. Final water flow rate in gpm.
   j. Voltage at each connection.
   k. Amperage for each phase.
   l.

N. Air-to-Air Heat-Recovery Unit Reports:
1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and type.
   e. Model and serial numbers.
2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
3. If fans are an integral part of the unit, include the following for each fan:
   a. Make and type.
   b. Arrangement and size.
   c. Sheave make, size in inches, and bore.
   d. Sheave dimensions, center-to-center, and amount of adjustments in inches.
4. Test Data (Indicated and Actual Values):
   a. Total exhaust airflow rate in cfm in all modes of operation.
   b. Purge exhaust airflow rate in cfm in all modes of operation.
   c. Outside airflow rate in cfm in all modes of operation
   d. Total exhaust fan static pressure in inches wg in all modes of operation.
   e. Total outside-air fan static pressure in inches wg in all modes of operation.
   f. Pressure drop on each side of recovery wheel in inches wg.

g. Exhaust air temperature entering in deg F.
h. Exhaust air temperature leaving in deg F.
i. Outside-air temperature entering in deg F.
j. Outside-air temperature leaving in deg F.
k. Calculate sensible and total heat capacity of each airstream in MBh.

O. Vibration Measurement Reports:
1. Date and time of test.
2. Vibration meter manufacturer, model number, and serial number.
3. Equipment designation, location, equipment, speed, motor speed, and motor horsepower.
4. Diagram of equipment showing the vibration measurement locations.
5. Measurement readings for each measurement location.
6. Calculate isolator efficiency using measurements taken.
7. Description of predominant vibration source.

P. Instrument Calibration Reports:
1. Report Data:
a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.21 INSPECTIONS

A. Initial Inspection:
1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:
a. Measure airflow of at least 10 percent of air outlets.
b. Measure water flow of at least 5 percent of terminals.
c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
d. Measure sound levels at two locations.
e. Measure space pressure of at least 10 percent of locations.
f. Verify that balancing devices are marked with final balance position.
g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:
1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.

4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.22 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Insulation Materials:
      a. Cellular glass.
      b. Flexible elastomeric.
      c. Mineral fiber.
      d. Polyisocyanurate.
   2. Adhesives.
   3. Mastics.
   4. Lagging adhesives.
   5. Sealants.
   6. Factory-applied jackets.
   7. Field-applied fabric-reinforcing mesh.
   8. Field-applied cloths.
   9. Field-applied jackets.
   10. Tapes.
   11. Securements.
   12. Corner angles.

B. Related Sections:
   1. Division 21 Section "Fire-Suppression Systems Insulation."
   2. Division 22 Section "Plumbing Insulation."
   3. Division 23 Section "Metal Ducts" for duct liners.
   4. Division 23 Section “Below Grade Preinsulated Piping”

1.3 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aeroflex
   2. Armacell
   3. Certain Teed Corp.
   4. Johns Manville
   5. Knauf Insulation
   6. Owens Corning
   7. Pittsburg Corning Corp.

8. Sound Seal

B. Listing of manufacturers name does not guarantee approval. All equipment must meet or exceed quality and capacities of specified equipment. Final approval will be based on equipment submittals. Any manufacturer not listed but wishing to bid this project shall submit a written request 14 days prior to bid date, prior approval is required for all manufacturers not listed.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:
1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type.

C. Qualification Data: For qualified Installer.

D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

E. Field quality-control reports.

F. Chilled water pump insulation installation instructions.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Provide duct lagging as specified on plans for areas that require sound attenuation.

F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Block Insulation: ASTM C 552, Type I.
   2. Special-Shaped Insulation: ASTM C 552, Type III.
   3. Board Insulation: ASTM C 552, Type IV.
   4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
   5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
   6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

H. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

K. Mineral-Fiber, Preformed Pipe Insulation:
   1. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   2. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

L. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

M. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

N. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
   1. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.
   2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches as tested by ASTM E 84.
   3. Fabricate shapes according to ASTM C 450 and ASTM C 585.
   4. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
      a. Pipe Applications: ASJ-SSL.
      b. Equipment Applications: ASJ-SSL.

O. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

P. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass, and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
   1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F.
   3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
   4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
   2. Service Temperature Range: 0 to 180 deg F.
   3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
   4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
   2. Service Temperature Range: Minus 50 to plus 220 deg F.
   3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 200 deg F.
   3. Solids Content: 63 percent by volume and 73 percent by weight.
   4. Color: White.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
   3. Service Temperature Range: Minus 50 to plus 180 deg F.
   4. Color: White.

2.5 SEALANTS

A. Joint Sealants: Cellular-Glass and Polyisocyanurate Products.
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Permanently flexible, elastomeric sealant.

3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.

C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.

2.8 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Adhesive: As recommended by jacket material manufacturer.
   2. Color: Color-code jackets based on system.
   3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
   4. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:
   1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
      a. Finish and thickness are indicated in field-applied jacket schedules.
      b. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
      c. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
      d. Factory-Fabricated Fitting Covers:
         1) Same material, finish, and thickness as jacket.
         2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         3) Tee covers.
         4) Flange and union cover.
         5) End caps.
         6) Beveled collars.

7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Underground Direct-Buried Jacket: Refer to Division 23 “Preinsulated below grade piping”.

F. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

G. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

H. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

I. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Width: 3 inches.
2. Film Thickness: 4 mils.
3. Adhesive Thickness: 1.5 mils.
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Width: 3 inches.
2. Film Thickness: 6 mils.
3. Adhesive Thickness: 1.5 mils.
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch in width.

2.11 SECUREMENTS

A. Bands:
1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch-thick, 1/2 inch wide with wing or closed seal.
2. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
3.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
a. Baseplate: Perforated, nylon sheet, 0.030-inch-thick by 1-1/2 inches in diameter.
b. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Baseplate: Galvanized carbon-steel sheet, 0.030-inch-thick by 2 inches square.
b. Spindle: Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
c. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.12 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040-inch-thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in Division 07 Section "Penetration Firestopping"irestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not over compress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.

g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation end around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:
1. Provide 1” cloes cell elastomeric on all chilled water pumps applied directly to pump housing. Install pump insulation per insulation manufacturer’s pump insulation installation instructions. Include pump insulation installation instructions with insulation submittals.
2. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached

insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of cellular-glass insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.8 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 75 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Impale insulation over pins and attach speed washers.
   f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 75 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not over compress insulation during installation.
   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1-inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.10 POLYISOCYANURATE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.

C. Insulation Installation on Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of polyisocyanurate insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.11 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:
   1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
   2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
   3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
   4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fish mouthing," and use PVDC tape along lap seal to secure joint.
   5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.12 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: Coat exposed outdoor flexible elastomeric insulation with two coats of manufacturer’s recommended protective white coating; or cover with aluminum jacketing all exposed outdoor flexible elastomeric insulation, in lieu of paint.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.13 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.14 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
1. Indoor, concealed supply, return, and outdoor air.
2. Indoor, exposed outdoor air.
3. Outdoor, concealed supply and return.
4. Outdoor, exposed supply and return.

B. Items Not Insulated:
1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Exhaust ductwork
4. Factory-insulated flexible ducts.
5. Factory-insulated plenums and casings.
6. Flexible connectors.
7. Vibration-control devices.
8. Factory-insulated access panels and doors.

3.15 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Supply-air Ducts, concealed (installed above ceilings), Exposed in Air-Conditioned Utility Spaces (Conditioned Mechanical Rooms or Mechanical Rooms used as Return Air Plenums), and Exposed in Non-Air Conditioned Spaces (Boiler Rooms, et. al):
1. Mineral-Fiber Blanket (All other areas): 2 inches thick and installed R-5.0.
2. Mineral-Fiber Board (Conditioned Mech. Room): 3 inches thick and 3-lb/cu. ft. nominal density.

B. Return Air Ducts, concealed (installed above ceilings), Exposed in Air-Conditioned Utility Spaces (Conditioned Mechanical Rooms or Mechanical Rooms used as Return Air Plenums), and Exposed in Non-Air Conditioned Spaces (Boiler Rooms, et. al.):

1. 1” thick flexible elastomeric duct liner.

C. Exposed Supply and Return Ductwork in Air Conditioned, Occupied Spaces, and Exhaust Air Ductwork:

1. Mineral-Fiber Blanket: 2 inches thick and installed R-5.0.

D. Outside-Air Ducts:
1. Mineral-Fiber Blanket: 2 inches thick and installed R-5.0.

3.16 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Supply-air, return-air and outside-air duct insulation shall be one of the following:
1. Mineral-Fiber Blanket: 3 inches and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

3.17 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Chilled-water pump insulation shall be one of the following:
1. Cellular Glass: 2 inches thick.
2. Polyisocyanurate: 1-1/2 inches thick.

D. Chilled-water expansion/compression tank insulation shall be one of the following:
1. Cellular Glass: 1-1/2 inches thick.
2. Flexible Elastomeric: 1 inch thick.
3. Polyisocyanurate: 1 inch thick.

E. Heating-hot-water expansion/compression tank insulation shall be one of the following:
1. Cellular Glass: 1-1/2 inches thick.
2. Flexible Elastomeric: 1 inch thick.
3. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
4. Polyisocyanurate: 1 inch thick.

F. Chilled-water air-separator insulation shall be one of the following:
1. Cellular Glass: 1-1/2 inches thick.
2. Flexible Elastomeric: 1 inch thick.

3. Polyisocyanurate: 1 inch thick.

G. Heating-hot-water air-separator insulation shall be one of the following:
1. Cellular Glass: 1-1/2 inches thick.
2. Flexible Elastomeric: 1 inch thick.
3. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
4. Polyisocyanurate: 1 inch thick.

3.18 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.19 INDOOR PIPING INSULATION SCHEDULE

A. Condensate, Cold Water Make-up and Equipment Drain Water:
1. All Pipe Sizes: Insulation shall be one of the following:
a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 3/4 inch thick.
c. Polyisocyanurate: 1 inch thick.

B. Chilled Water Supply and Return:
1. Insulation shall be:
a. Polyisocyanurate: 1-1/2 inches thick.

C. Heating-Hot-Water Supply and Return:
1. NPS 1-1/2” and Smaller: Insulation shall be one of the following:
a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.
b. Polyisocyanurate: 1-1/2 inches thick.
2. NPS 2” and Larger: Insulation shall be the following:
a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.
b. Polyisocyanurate: 2 inches thick.

D. Refrigerant Suction and Hot-Gas Piping:
1. Suction piping insulation shall be a minimum of 3/4” thick.
2. Insulation shall be installed per the manufacturer’s recommendations.

3.20 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:
1. All Pipe Sizes: Insulation shall be as recommended by the manufacturer. Provide aluminum jacketing for all exterior piping insulation.

3.21 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Division 33 piping distribution Sections.

B. Refer to Division 23 “Below Grade Preinsulated Piping” issued under the Early Site Package.

3.22 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts, Plenums, and Piping concealed (installed above ceilings) and Exposed in Air-Conditioned Occupied Spaces:
   1. None.

D. Ducts, Plenums, and Piping Exposed in Air-Conditioned Utility Spaces (Conditioned Mechanical Rooms and Mechanical Rooms used as Return Air Plenums):
   1. 8-ounce canvas with lagging adhesive.

E. Ducts, Plenums, and Piping, Exposed in Non-Air-Conditioned Spaces (Boiler Rooms, et. al.):
   1. PVC: 20 mils thick (N/A if installed in a return air plenum).
   2. Chilled-Water Piping:
      a. Background Color: Per current UNC Charlotte Facilities standard.
      b. Letter Color: Per current UNC Charlotte Facilities standard.
   3. Heating Water Piping:
      a. Background Color: Per current UNC Charlotte Facilities standard.
      b. Letter Color: Per current UNC Charlotte Facilities standard.
   4. Refrigerant Piping:
      a. Background Color: Per current UNC Charlotte Facilities standard.
      b. Letter Color: Per current UNC Charlotte Facilities standard.

F. Equipment, concealed (installed above ceilings):
   1. None.

G. Equipment Exposed (all applications):
   1. PVC: 20 mils thick (N/A if installed in a return air plenum)
   2. Aluminum, Smooth: 0.016 inch thick.

3.23 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
   1. Painted Aluminum, Smooth: 0.016 inch thick.

D. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
   1. Aluminum, Smooth with: 0.032 inch thick.

E. Piping, Concealed:
   1. None.

F. Piping, Exposed:
   1. Aluminum, Smooth: 0.016 inch thick.

3.24 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 230700

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 OVERVIEW

A. Furnish all labor, materials, equipment, and service necessary for a complete and operating electric/ electronic temperature control system utilizing Direct Digital Controls as shown on the drawings and as described herein.

B. All labor, material, equipment and software necessary to meet the functional intent of the system as specified herein and as shown on the drawings shall be included. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans, that are required to meet the functional intent, shall be provided without additional cost to the Owner.

1.2 DESCRIPTION

A. This section and the accompanying drawings cover the provisions of all labor, equipment, appliances and materials and performing all operations in connection with the construction and installation of the Direct Digital Controls as specified herein and as shown. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with hardware, software, and interconnecting wire and conduit. Include installation and calibration, supervision, adjustments, and fine-tuning necessary for complete and fully operational system. This work includes, but is not limited to the following:
1. Direct Digital Controllers.
2. Interface with campus Building Automation System (BAS) as specified or shown on drawings.
3. Control panels *(main and remote).
4. Thermostats.
5. Temperature and pressure sensors.
6. Control valves and dampers with actuators.
7. Life safety shutdowns and interlock wiring.
8. Relays, contactors, and transformers
9. Controls Wiring and Installation (24 and 120 volt).

B. RELATED WORK
1. See the following related sections:
   a. General Requirements: Division 01.
   b. Related Mechanical Work: Division 23.
   c. Related Electrical Work: Division 26.

1.3 SYSTEM FEATURES AND ARCHITECTURE

A. UNC Charlotte intends to monitor and control the entire system from an existing browser-based Facility Management System (FMS). A Niagara AX server is located in Physical Plant. It is the intent of the University to integrate this project and all future campus direct digital control systems to this Niagara AX server using the competitive bid process. The entire FMS system including the products and labor detailed in specifications shall be provided by one of the acceptable control system integrators. Provide the appropriate number of Niagara AX based NAC(s) to integrate DDC system as necessary. NAC(s) to be JACE 7 series. Hard drives are not acceptable. Provide "Export Tagging" controls programming as required to simplify importing the JACE controls, points list and graphic control screens to join the existing UNCC server platform.

B. The FMS shall be capable of total integration of the facility infrastructure systems with browser access to all system data either locally over a secure Intranet within the campus and by remote VPN access and a standard Web Browser over the Internet. The scope shall include HVAC control and tuning, electrical, gas and water metering, energy management, alarm monitoring, and all trending, reporting and maintenance management functions related to normal building operations all as indicated on the drawings or elsewhere in this specification.

C. Power Fail Protection - All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the ASC or FPC.

D. The entire Facility Management System (FMS) shall be comprised of a network of interoperable, stand-alone digital controllers communicating via an open protocol communication network to the Niagara AX based UNC Charlotte workstation detailed in section 2.14. The communication from a building to the workstation shall be standardized for maintenance and trouble-shooting considerations and shall be via a Network Area Controller (NAC) over the existing Fiber Optic Network.

E. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate both the ANSI/ASHRAE Standard 135-1995 BACnet and LonWorks technology communication protocols in one open, interoperable system.

F. The existing Niagara AX software system shall employ component-oriented technology (COT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-2010, BACnet and LonMark to assure interoperability between all system components is required. The system supplier must provide a PICS document showing the installed systems compliance level. Minimum compliance is Level 3.

G. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on the existing workstation for all database access.

H. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.

I. The Campus LAN is an existing fiber optic, 10/100 Megabits/sec Ethernet network supervised by the campus ITS group'. The new FMS shall utilize the network infrastructure to support BACnet, Java, XML, and HTTP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), and user workstations. The Ethernet communication protocols must be fully compatible with the Campus Wide Ethernet communication specifications. The Systems Integrator must coordinate with the Campus Telecommunications Group to attain written approval from the Group to operate on the Campus Wide Network.

J. UNC Charlotte access to the FMS shall be via a standard Internet browser from a remote location utilizing VPN, from a standard browser within the campus network or from a local workstation by direct connection to the Campus LAN. The Control Systems Integrator must provide a connection from every Network Area Controller (NAC) to the campus network to enable this access.

K. The Systems Integrator shall include installation of conduit and thin-wire Ethernet cable from the building's NAC to the closest telecommunications uniform wiring closet in the building. The Owner shall arrange for an Ethernet connection to be available at a hub within the closest wiring closet. Any material or hardware required for the Ethernet connection at the NAC shall be the responsibility of the Systems Integrator.

L. Provide integration of the new Variable Speed Drives and new Variable Speed Pumping Systems via a Modbus, Lon or BACnet interface provided by the equipment manufacturer. Provide graphics at the FMS to visualize the appropriate information from these systems at the FMS. The cost for all the communication interface hardware and software shall be borne by the successful Systems Integrator except as follows:
   1. New Variable Speed Drive systems manufacturer shall provide a Modbus , BACnet over Ethernet or LonWorks Interface to the NAC.

1.4 SYSTEM PROGRAMMING

A. The system supplied by the SI must be programmed using a palette of control, application, and graphical components provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control components from the palette, dragging or pasting them on the screen, and "wiring" them together using a built-in graphical connection tool. All completed applications must be stored in the UNC Charlotte AX Workstation software palette for future use by any future SI selected by UNC Charlotte. Graphical User screens are created in the same fashion. Data for the user screens is obtained by graphically linking the graphical components to the application components to provide "real-time" data updates. Any real-time data value or component property may be connected to display its current value on a user screen. Systems requiring separate software tools or processes to create applications and user interface screens shall not be acceptable.

B. Programming Methods:
   1. Provide the capability to copy component s from the supplied palette, or from a user-defined palette to the user's application. Components shall be linked by a graphical linking scheme by dragging a link from one component to another. Component links will support one-to-one, many-to-one, or one-to-many relationships. Linked components shall maintain their connections to other components regardless of where they are positioned on the page and shall show link identification for links to components on other

pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.

2. Configuration of each component will be done through the component's property sheet using fill-in the blank fields, list boxes, and selection buttons. Requiring the use of custom programming, scripting language, or a manufacturer-specific procedural language for every component configuration will not be accepted.
3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
4. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database component s shall not be allowed.
5. The system shall support component duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

1.5 GRAPHICAL USER INTERFACE SOFTWARE

A. UNC Charlotte has licensed a Niagara ^{AX} Supervisor for the development of their FMS logic and graphics. This user interface shall allow, with proper password access, full interaction with the system including, but not limited to, viewing and modifying data, database administration, configuration of communications parameters, password and security administration, programming and configuration of components, receipt, routing and acknowledgement of alarms, and development of graphic screens.

B. The user interface shall employ browser-like functionality for ease of navigation. It shall include a tree view for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation techniques similar to those in a commercially available Web Browser. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected component identification.
   1. Graphic screens shall be developed using any drawing package capable of generating a .GIF, .BMP, or .JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of, a graphic background, the user interface shall support the use of scanned pictures.
   2. Graphics developed for the user interface shall be capable of being used by a standard Web Browser client, without the need to develop additional graphic screens specifically for the Web Browser.
   3. Graphic screens shall have the capability to be overlaid with text, real-time values, command and adjust, animation, color spectrum, logs, graphs, HTML document links, and schedule graphic components, as well as links to other graphic screens.
   4. Modifying common application components, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
   5. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
   6. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

7. Commands issued to start and stop binary components shall be done by right-clicking the selected component and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
8. Adjustments to analog components, such as set points, shall be done by right-clicking the selected component and using a graphical slider to adjust the value. No entry of text shall be required.

1.6 FMS GRAPHICS

A. The successful SI will be responsible for building new graphics from existing templates. The graphics shall be coordinated with UNC Charlotte staff and shall be similar to standards developed in previous Niagara systems. The Integrator will be responsible for creating web pages within the supplied system with new information, links, etc. as buildings or systems are added. It is the SI's responsibility to remain knowledgeable about the University's standard FMS procedures, web page style and existing palette of components prior to bidding the next project. A pre-engineering meeting shall be arranged between the systems integrator and the owner to discuss each project specifically before engineering and graphics developments begin. The following are mandatory requirements for each site.
   1. Each graphics screen shall include the approved UNCC look and links across the top per the graphics template.
   2. Deleted (reference to campus map).
   3. The systems integrator is responsible for providing a link to the control drawings (.dwf format) for each associated piece of equipment. A button for control drawings shall be located on the UNCC frame navigation bar. On integration projects, where existing controls exist, UNCC shall be responsible for providing the control drawings (.dwf format) to the systems integrator. On new projects the systems integrator shall be responsible for providing the as-built control drawings. Note the system shall be engineered in such a way that the control drawings will be accessible with a standard browser-utilizing WHIP! or Volo View Express (Auto-Cad will not be required).
   4. The systems integrator is responsible for providing a link to the operating and maintenance manuals for each major piece of equipment (Chiller, Boiler, Pumps, VFDs). This link shall be located on the graphic for each piece of equipment, per the template. UNCC will provide the O&M data (.pdf format) and shall install it on the UNCC FMS network server for use by the systems integrator.
   5. All graphics shall have a resolution of 1280 by 800 pixels. (Confirm with owner before graphics development.)
   6. All graphics shall be designed for viewing using Internet Explorer 8.0 or whatever may be UNCC standard at the time of deployment (not at time of submittals).
   7. All graphics shall be standard from the UNCC FMS graphics palette.
   8. Any custom graphics that do not originate from the UNCC FMS graphics palette will require UNCC approval prior to deployment. The UNCC approved graphics will be installed in the UNCC FMS graphics palette located on the hard drive of the UNCC server by the systems integrator for future use as needed.
   9. Any graphics work developed and provided by the Systems Integrator for any UNCC project shall become the property of UNCC and shall be available for use by any other Systems Integrator on a UNCC project. (UNCC wishes to reuse and standardize on graphics and ideas that work well).
   10. The systems integrator shall submit to UNCC (2) copies of a graphical proposal. The graphical proposal shall include written and graphical representation of proposed Web-based, FMS navigational user interface including screen shots to be used for the proposed

project. Software graphical proposals viewable with a browser, delivered on compact disc or available via the Internet are acceptable.

1.7 WEB BROWSER CLIENTS

A. The system shall be capable of supporting an unlimited number of clients using a standard Web Browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software resident on the client machine or manufacture-specific browsers shall not be acceptable.

B. The Web Browser client shall support, at a minimum, the following functions:
   1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication techniques to prevent unauthorized access shall be implemented.
   2. Graphical screens developed for the GUI shall be the same screens used for the Web Browser client. Storage of the graphical screens shall be in the system, without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
   3. Depending on user access privileges, the user shall be able to view data, modify and command components such as start/stop, and adjust set points. In addition, users can be provided with the ability to view logs and view and acknowledge alarms.
   4. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. The capability to limit the user to just their home page shall be provided. From the home page, links to other views, or pages in the system shall be possible.
   5. Graphic screens on the Web Browser client shall support hypertext links to other Web pages on other Internet or Intranet sites.

1.8 COMPONENT LIBRARIES

A. A standard palette of components shall be included by UNC Charlotte for development and setup of application logic, user interface displays, system services, and communication networks. The successful Systems Integrator may be required to develop new components to meet the intent of this specification. Any new components created must be stored in the UNC Charlotte component palette for future use. It is the responsibility of the Systems Integrator to verify what components exist in the UNC Charlotte palette prior to bidding this project.

B. The components in this palette shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group components created in their application and store the new instances of these components in a user-defined palette.

C. The successful systems integrator shall update the UNC Charlotte standard palette specified here to provide new or updated components and applications as they are developed by the software manufacturer.

D. The Systems Integrator shall be responsible for timely verification that the UNC Charlotte palette includes services and components to support the particular LonWorks and BACnet

devices that the SI proposes to bid and install. If the components do not exist or will not exist in time to install this particular project, the SI must utilize a component that does exist.

1.9 LOAD CONTROL PROGRAMS

A. General: Support inch-pounds and S.I. metric units of measurement.

B. Automatic Time Scheduling:
1. Self-contained programs for automatic start/stop.
2. Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary day schedules.
3. Special days schedule shall support up to 30 unique date/duration combinations.
4. Any number of loads assigned to any time program; each load can have individual time program.
5. Each load assigned up to 8-time schedules per day with 1-minute resolution.
6. Time schedule operations may be:
    a. Start.
    b. Optimized start.
    c. Stop.
    d. Optimized stop.
7. Minimum of 30 holiday periods up to 365 days in length may be specified for the year.
8. Controller shall be able to account for daylight savings time.

C. Start/Stop Time Optimization:
1. Perform optimized start/stop as function of outside conditions, inside conditions, or both.
2. Adaptive and self-tuning, adjusting to changing conditions unattended. Set Inactive.
3. For each point under control, establish and modify:
    a. Occupancy period.

D. Calculated Points: Define calculations and totalization computed from monitored points (analog/digital points), constants, or other calculated points.
1. Employ arithmetic, algebraic, Boolean, and special function operations.
2. Treat calculated values like any other analog value, use for any function that a "hard wired point" might be used.

E. Event Initiated Programming: Event may be initiated by any data point, causing series of controls in a sequence.
1. Define time interval between each control action.
2. Output may be analog value.
3. Provide for "skip" logic.
4. Verify completion of each action.

F. Direct Digital Control: Each control unit shall provide Direct Digital Control software so that the operator may customize control strategies and sequences of operation by defining the appropriate control loop algorithms and choosing the optimum loop parameters.
1. Control loops: Defined using "modules" that are analogous to standard control devices.
2. Output: Paired or individual digital outputs for pulse-width modulation, and analog outputs, as required.
3. Firmware:
    a. PID with analog or pulse-width modulation output.

b. Floating control with pulse-width modulated outputs.
c. Two-position control.
d. Primary and secondary reset schedule selector.
e. Hi/Lo signal selector.
f. Digital output.
g. Time delay function with delay before break, delay before making and interval time capabilities.

4. Direct Digital Control loops: Downloaded upon creation or on operator request. On sensor failure, program shall execute user defined failsafe output.
5. Display: LCD type.
6. Fine Tuning Direct Digital Control PID or floating loops:
   a. Display Information:
      1) Control loop being tuned.
      2) Input (process) variable.
      3) Output (control) variable.
      4) Setpoint of loop.
      5) Proportional band.
      6) Integral (reset) interval.
      7) Derivative (rate) interval.
   b. Display Format: LCD type.

1.10 HVAC CONTROL PROGRAMS

A. General: Identify each HVAC Control System.

B. Optimal Run Time:
1. Control start-up and shutdown times of HVAC equipment for cooling.
2. Base on occupancy schedules, outside air temperature, seasonal requirements.
3. Operator commands:
   a. Define term schedule.
   b. Lock/unlock program.
4. Control Summary:
   a. HVAC Control system begin/end status.
   b. PRODUCTS Optimal run time lock/unlock control status.
   c. Cooling mode status.
   d. Optimal run time schedule.
   e. Start/Stop times.
   f. Optimal run time system normal start times.
   g. Occupancy and vacancy times.
5. HVAC Point Summary:
   a. Control system identifier and status.
   b. Point ID and status.
   c. Outside air temperature point ID and status.
   d. Period start.

1.11 PROGRAMMING APPLICATION FEATURES

A. Alarm Messages:
1. Output assigned alarm on LCD display; low/high and status alarms.

B. Weekly Scheduling:
   1. Automatically initiate equipment or system commands based on preselected time schedule for points specified.
   2. Provide program times for each day of week, per point.
   3. Automatically generate alarm output for points not responding to command.
   4. Provide for holidays.
   5. Operator commands:
      a. System logs and summaries.
      b. Optimal run timStart/stop point.
      c. Add, delete, or modify analog limits and differentials.
      d. Adjust point operation position.
      e. Change point operational mode.
      f. Open or close point.
      g. Begin or end point totalization.
      h. Modify totalization values and limits.
      i. Access or secure point.
      j. Begin or end HVAC or load control system.
      k. Modify load parameter.
   6. Output Summary: Listing of programmed function points, associated program times, and respective day of week programmed points by software groups or time of day.

C. Interlocking:
   1. Permit events to occur, based on changing condition of one or more associated master points.
   2. Binary contact, high/low limit of analog point or computed point shall be capable of being utilized as master. Same master may monitor or command multiple slaves.
   3. Operator Commands:
      a. Define single master/multiple master interlock process.
      b. Define logic interlock process.
      c. Lock/unlock program.
      d. Enable/disable interlock process.

1.12 UTILITY MONITORING SOFTWARE INTEGRATION

A. The University of North Carolina at Charlotte is using Periscope™ by ActiveLogix as its energy profiling/analysis software tool. The Periscope™ software is currently loaded on the FMS server. The Systems Integrator is responsible for providing trends for integration into Periscope™ . The Systems Integrator will provide an energy/utility dashboard for this project using the Periscope™ software.

B. System shall provide browser access to unit controllers and associated setpoints and tuning parameters. The Building Automation System shall be comprised of BACnet or LonMark/LonTalk controllers. Should the NAC network connection be interrupted, the DDC components shall continue to provide local control using the last known state of any global variables (OA temperature, Demand Value, Price of Energy, etc.) It shall be the DDC contractor's responsibility to effectively design and program standalone control while coordinating the required DDC integration and communication to the NAC.

1.13 SOFTWARE LICENSE AGREEMENT

A. The Owner has signed a software and firmware licensing agreement for the FMS software. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement but shall protect manufacturer's rights to disclosure of trade secrets contained within such software. Systems Integrators that participate in the integration of UNC Charlotte's direct digital control systems must:
   1. Be certified in the use, application and service of Niagara AX software and shall provide documentation from the manufacturer's training center as such. However, certification in the above does not automatically qualify an integrator to bid on proposed UNC Charlotte projects. Only approved integrators listed in this specification are eligible to participate in the project.
   2. Agree to use on any UNC Charlotte project any application standards, html pages, graphics templates, etc. developed by or for UNC Charlotte for the purpose of digital control, scheduling, alarming, graphics, etc.
   3. Agree that the application standards, html pages, graphics templates, etc. developed by or for UNC Charlotte are the property of UNC Charlotte (subject to the manufacturer's license agreement) and shall not be reproduced, etc. for use on any other customer, project, etc. without the expressed written permission of the UNC Charlotte facilities staff.
   4. Agree that certification on the manufacturer's software does not guarantee continued participation in UNC Charlotte's FMS projects.
   5. Agree to provide UNC Charlotte's staff with the highest level of administrative password.
   6. Agree that UNCC staff and other Systems Integrators can use the onsite UNCC software tools to modify NACs, license files, passwords, provide software maintenance, etc after warranty period expires.

B. The owner requires that all Niagara Ax based software and hardware on this project have the following Niagara Information Compatibility Statement (NICS). The Existing Niagara AX Server complies with the requirements below. Organizations without the NICS below shall not be allowed to bid.
   1. Brand ID = Vykon
   2. Station Compatibility In = *
   3. Station Compatibility Out = *
   4. Tool Compatibility In = *
   5. Tool Compatibility Out = *

1.14 ACCEPTABLE CONTROL SYSTEM INTEGRATORS/CONTROL SYSTEM MANUFACTURES:

A. Application engineers working on this project shall be required to be certified in Niagara AX and certified by the DDC controls manufacturer to perform all engineering services. The Systems shall be installed by trained mechanics either in direct employ of Systems Integrator or by subcontractors who are under direct supervision of Systems Integrator's field representative. Submit resumes of application engineers and field supervisors to be assigned to this project within 30 days after contract award. Application engineers shall have prior experience with at least 2 similar types of projects. Engineer reserves right to exclude any engineers or field supervisors whose past experience is not sufficient to meet the needs of the project.

B. Systems Integrators labor shall include, but is not limited to:
   1. Engineering services to size all valve and dampers based on design criteria specified.
   2. Engineering services to produce all submittals requested and working construction drawings and record drawings as specified here within.
   3. Engineering services for all software programming required.
   4. Engineering services for all software programming specified.
   5. Project management services with single point contact to coordinate all construction related activities.
   6. Field mechanics for installation of pneumatic tubing and related control devices.
   7. Field mechanics for installation of control wiring and related control devices.
   8. Field technicians to start-up, calibrate, adjust and tune all control loops per specifications.
   9. Field technicians to perform system checkout, testing and complete required reports.
   10. Full time field supervisor during controls installation and start-up.
   11. Field technicians to assist testing and balancing contractor in adjusting controls and determining set points related to his scope of work.
   12. Field representatives and/or classroom instructors to provide Owner training as specified.

C. Controls System Integrator shall be responsible for complete installation of all control devices, except as noted, wiring and pneumatic terminations at panel locations to accomplish control sequences specified in this project manual or on drawings. System Integrator is also responsible for any additional instrumentation described in any point schedules found in this contract document, which may not be directly related to any specified control sequences.

1.15 SUBMITTALS

A. Submittals shall be coordinated through the control systems integrator provided as a part of this controls contract. This contractor shall incorporate DDC submittals and all other associated Ethernet or serial communication devices not provided by this contractor into the electronic submittals. This contractor shall be responsible for verification that the sequence of operations is inclusive of all requirements and properly coordinates the division of work. Submittal requirements include:
   1. Product Data:
      a. Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   2. Shop Drawings:
      a. Submit manufacturer’s printed product data sheets for all control devices and all materials listed in bill of material in control drawings. Organize sheets in order of model number, alphabetically, then numerically. If more than 20 product data sheets are submitted, provide front index and tabs for logical groups of devices.
      b. Submit control drawings with a front sheet index for projects with more than 10 control drawing sheets.
      c. Overall system/network architecture drawings: Provide schematic drawing showing relationship of each controller, control panel or other network devices relative to each other, label room location of each device, number and indicate model number of each device, indicate network types and general cabling routing.
      d. Schematic Control Drawings: Include graphic representation of systems with all major inline components to properly locate all control devices. Identify controlled

devices with their software designation on drawings, including unique valve and damper tag numbers.

e. Control Logic Drawings: Include graphical programming logic drawings with all controllers and associated parameters, logic, inputs, outputs and control loops.

f. Control Points List: As part of Schematic Control Drawings (see #4 above), include tabular representation of all points associated with a given DDC controller (hardware and software points) and provide the following information about each point:
   1) Is point exposed on graphic page?
   2) Is point commandable/adjustable by UNCC from graphic?
   3) Is point scheduled?
   4) Is point trended? How many samples? Is trend archived to server? Is trend archived to Periscope™?
   5) Is point alarmed? What are high/low alarm limits?
   6) What are point units (i.e. DEG F, etc)?

g. Detailed wiring and piping diagrams showing point to point hookup details of all transducers, relays, outputs, inputs and subsystem components. Label all pneumatic lines and control wires with field ID numbers/colors.

h. Bill of material identifying actual product model number used for each control device for each schematic control drawing.

i. Sequence of Operation: Verbally describe each control sequence indicating method of control. Identify sensors, controllers and actuators used with references to tag number of the controlled device. Include set points and offsets of each control loop.

j. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

k. Schedule of dampers and valves including size, leakage, and flow characteristics.

1.16 COMPLETION CHECKLIST

A. Submit with shop drawings a detailed completion checklist including written procedures for adjusting and calibrating each type of controller, instrument and sensor. Checklist shall also include step-by-step written procedure to functionally test each type of control loop or logic sequence. The Engineer reserves right to request modifications to any procedure which is incomplete or not adequate to prove system performance.

B. Check list to include references to the following additional requirements:
   1. Instruments and sensors shall be calibrated by comparison to known device, which is traceable to National Institute of Standards and Testing.
   2. Check each point for calibration, connection to correct control loop and that limit and alarm values are properly set.
   3. Transducers and other output devices shall be properly zeroed and calibrated at both minimum and maximum output. Control contractor shall coordinate with testing, adjusting and balancing contractor to determine flows at minimum and maximum conditions for each device.
   4. Tune control loops to maintain controlled process variable at set point throughout the year without cycling or requiring modifications to control system. AUTO TUNING IS NOT ACCEPTABLE.
   5. Performance tests of all analog control loops shall be performed by changing set point and verify that sequence can come into stable equilibrium within reasonable time period

which is appropriate for that sequence. Use load changes for all pressure and flow control loops.

6. System performance shall be documented via 48 hour printed trend log report of actual output performance versus set point.
7. Perform tests of discrete control loops by adjusting set point and verifying sequence action.
8. All alarms, including network failures, to be tested for each controller and device connected to network, and ensure that alarms are properly acknowledged at control panel.

1.17 EXTENDED SERVICE AGREEMENT

A. Control manufacturer shall, upon completion of warranty period, make available to Owner annual service agreement covering all labor and material required to effectively maintain control system after warranty period. Owner reserves rights to accept or reject any such offers and to cancel ongoing agreement with 30-day written notice.

1.18 SUBMITTALS FOR INFORMATION

A. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.

1.19 SUBMITTALS AT PROJECT CLOSEOUT

A. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
   1. Revise shop drawings to reflect actual installation and operating sequences.
   2. Include data specified in “Submittals” in final “Record Documents” form.

B. Provide 3 hard copies and 1 electronic copy of O&M Manuals. Provide drawings in ACAD format.

C. Operation and Maintenance Data:
   1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
   2. Include step-by-step procedures indexed for each operator function.
   3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
   4. Calibration records and list of set points.

1.20 QUALITY ASSURANCE

A. The Manufacturer of the interoperable controllers shall provide documentation supporting compliance with ISO-9001 (Model for Quality Assurance in Design/Development, Production, Installation and Servicing). Product literature provided by the interoperable controller manufacturer shall contain the ISO-9001 Certification Mark from the applicable registrar.

1.21 WARRANTY AND SERVICE

A. The controls contractor shall warrant the system to be free from defects in material and workmanship for a period of two (2) year from the date of completion and acceptance of the work by the owner. Any defects shall be repaired or replaced, including materials and labor at no cost to the owner.

B. The controls contractor shall provide two (2) years of maintenance service for the controls system to begin concurrently with the 1st year of warranty. Service shall include inspection and adjustment of all operating controls and components. The service shall be performed every 6 months and documentation of service shall be provided to Facilities Operations.

1.22 EXTRA MATERIALS

A. Furnish the following extra materials to Facilities Operations at completion:
1. 2 water temperature sensors.
2. 1 space humidity type sensor.
3. 1 duct type humidity sensor.
4. 2 zone thermostats.
5. 2 zone carbon dioxide monitors.
6. 2 VAV box DDC Controllers.
7. 1 duct type temperature sensor.

1.23 COORDINATION

A. This contractor shall coordinate with the other contractors as required to produce workable, controllable systems. Generally, all control and monitoring equipment shall be furnished and installed by this contractor unless otherwise noted. The controls contractor may subcontract the wiring of direct digital controls system. Specific examples of coordination and cooperation include:
1. Smoke detection system shall be furnished and wired to the fire alarm system by the electrical subcontractor.
2. Duct mounted smoke detectors shall be installed by the mechanical subcontractor. The electrical contractor shall provide contacts for air handler shut down at the fire alarm panel. This DDC contractor shall wire from these contacts and incorporate into the air handler controls.

1.24 APPLICATION SOFTWARE DOCUMENTATION

A. Contractor shall provide a copy of all BACnet or Lonworks .xif files and system databases on Compact disk.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials and equipment used shall be standard components and regularly manufactured for this application. All systems and components shall have been thoroughly tested and proven in actual use.

2.2 STATEMENT OF COMPLIANCE WITH SPECIFICATIONS

A. Bidders shall submit statement of compliance with the bid package, for review by the Owner's authorized representatives, a written line by line statement of compliance to the specifications related to the automatic control and building automation system.

2.3 EQUIPMENT

A. Network Area Controller (NAC)
   1. The NAC shall provide the interface between the Campus LAN and the field controllers. NACs shall be based on Niagara ^{AX} software and shall be provided with the OBIX driver. Provide the following NICS in each NAC:
      a. Brand ID = Vykon
      b. Station Compatibility In = *
      c. Station Compatibility Out = *
      d. Tool Compatibility In = *
      e. Tool Compatibility Out = *
   2. The NAC shall provide multiple user access to the system and support for ODBC or SQL. An embedded database resident on the NAC must be an ODBC-compliant database or must provide an ODBC data access or must provide an ODBC data access mechanism to read and write data stored within it. A minimum offering would be the documentation of database schemes to allow users to read/write data into other applications using appropriate ODBC syntax.
   3. The NAC must provide all tools for Java enabled Web browser access via the Intranet/Internet.
   4. Event alarm Notification and Actions:
      a. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers. Object alarm properties shall conform to the alarm properties as defined in the BACnet specification.
      b. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.
      c. Alarms shall have the capability to be routed to e-mail messages and paging services that support receipt of e-mail messages.
      d. The NAC shall provide a timed (scheduled) routing of alarms by component, group or code.
      e. The NAC shall include a master clock service for its subsystems and provide time synchronization for all distributed controllers. The NAC shall also be programmed

to accept time synchronization messages from trusted precision Atomic Internet Clock sites to update its master clock time.

5. Data Collection and Storage:
   a. The NAC shall be provided with the ability to collect data for any property of any component and store this data for future use.
   b. The data collection shall be performed by a log component that shall have, at a minimum, the following configurable properties:
   c. Designating the log as interval or deviation.
   d. For interval logs, the component shall be configured for time of day, day of week and the sample collection interval.
   e. For deviation logs, the component shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the component.
   f. For all logs, provide the ability to set the maximum number of data stores and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.

B. Interoperable Lonmark Controller (ILC):
   1. Controls shall be microprocessor based Interoperable LONMARK Controllers (ILC), bearing the applicable LONMARK interoperability logo on each product delivered. ILCs shall be provided. ILCs shall be based on the Echelon Neuron 3150 microprocessor working from software program memory, which is physically located in the ILC. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
   2. To simplify controls and mechanical service troubleshooting, the ILC shall be mounted directly in the control compartment of the unitary system. The ILC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment.
   3. The ILCs shall communicate with the NAC at a baud rate of not less than 78.8K baud. The ILC shall provide LED indication of communication and controller performance to the technician, without cover removal.
   4. The ILCs shall be fully supported and communicate with the FMS Graphical User Interface (GUI).
   5. The ILC Sensor shall connect directly to the ILC and shall not utilize any of the I/O points of the controller. The ILC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The ILC Sensor shall provide a communications jack for connection to the LON communication trunk to which the ILC controller is connected. The ILC Sensor, the connected controller, and all other devices on the LON bus shall be accessible by the POT.
   6. All input/output signals shall be directly hardwired to the ILC. For all non-VAV terminal applications, a minimum of two input points of the ILC shall employ a universal configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current sourced inputs. If universal points are not available, a minimum of two input points (each) of the dry contact, resistive and analog voltage/current types must be provided on every controller. The outputs of the ILC shall be of the relay and universal analog form. All digital outputs shall be relay type. ILC devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices. Configuration of all I/O points shall be accomplished without physical hardware jumpers,

switches or settings. Troubleshooting of input/output signals shall be easily executed with the POT or a volt-ohm meter (VOM). All I/O points shall be utilized by the local ILC or shall be available as I/O points for other controllers throughout the network.

7. All ILCs shall be fully application programmable and shall at all times maintain their LONMARK certification. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the ILC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
8. The ILC shall be provided with the ability to interface with the POT. The interface port shall be provided at the wall sensor or within the unitary equipment, as specified on the plans. The interface port shall allow the POT to have full functionality as described in POT section of this specification.

C. Interoperable Digital Controller (IDC):
1. Controls shall be microprocessor based Interoperable LonWorks Digital Controllers (IDC), providing interoperability with all LONMARK and LonWorks devices. IDCs shall be provided for any equipment applications as required, as shown on the drawings. IDCs shall be based on the Echelon Neuron Hosted microprocessor architecture, working from software program memory that is physically located in the IDC. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
2. All IDCs shall be fully application programmable utilizing graphical components. All control sequences programmed into the IDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Systems that only allow selection of sequences from a palette or table are not acceptable.
3. The IDC shall be provided with the ability to interface with the POT. The interface port shall allow the POT to have full functionality as described in POT section of this specification. Through the interface port all IDC devices on the LON bus shall be accessible by the POT.
4. The IDCs shall communicate with the NAC at a baud rate of not less than 78.8K baud. The IDC shall have as a minimum ambient operating temperature range of 32 to 122 degrees Fahrenheit.
5. The IDC shall be fully supported by the Graphical User Interface (GUI).
6. All input/output signals shall be directly hardwired to the IDC. All controllers shall employ a universal input configuration that allows for flexibility in application ranging from dry contact, resistive and voltage/current-source inputs. If universal points are not available, a minimum of one spare input point (each) of the dry contact, resistive and analog voltage/current types must be provided for each input point utilized. IDC devices shall provide digital and analog output types and quantities consistent with the requirements of the application requirements. Troubleshooting of input/output signals shall be easily executed with the POT or a volt-ohm meter (VOM). All I/O points shall be utilized by the local ILC or shall be available as I/O points for other controllers throughout the network.

D. Interoperable BACNET Controller (IBC):
1. Controls shall be microprocessor based Interoperable BACnet Controllers (IBC) in accordance with the ANSI/ASHRAE Standard 135-1995. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals. The system supplier must provide a PICS document showing the installed systems compliance level to the ANSI/ASHRAE Standard 135-1995. Minimum compliance is Level 3.

2. To simplify controls and mechanical service troubleshooting, the IBC shall be mounted directly in the control compartment of the unitary system. The IBC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment.
3. The IBCs shall communicate with the NAC at a baud rate of not less than 78.8K baud. The IBC shall provide LED indication of communication and controller performance to the technician, without cover removal.
4. The IBCs shall be fully supported and communicate with the FMS Graphical User Interface (GUI).
5. The IBC Sensor shall connect directly to the IBC and shall not utilize any of the I/O points of the controller. The IBC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The IBC Sensor shall provide a communications jack for connection to the BACnet communication trunk to which the IBC controller is connected. The IBC Sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the POT.
6. All input/output signals shall be directly hardwired to the IBC. For all non-VAV terminal applications, a minimum of two input points of the IBC shall employ a universal configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current sourced inputs. If universal points are not available, a minimum of two input points (each) of the dry contact, resistive and analog voltage/current types must be provided on every controller. The outputs of the IBC shall be of the relay and universal analog form. All digital outputs shall be relay type. IBC devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices. Configuration of all I/O points shall be accomplished without physical hardware jumpers, switches or settings. Troubleshooting of input/output signals shall be easily executed with the POT or a volt-ohm meter (VOM). All I/O points shall be utilized by the local IBC or shall be available as I/O points for other controllers throughout the network.
7. All IBCs shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the IBC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
8. The IBC shall be provided with the ability to interface with the POT. The interface port shall be provided at the wall sensor or within the unitary equipment, as specified on the plans. The interface port shall allow the POT to have full functionality as described in POT section of this specification.

E. Application Specific Controllers (ASC):
1. ASC's shall be designed through its I/O configuration and configurable control logic to be used for a specific type mechanical equipment. Typical applications are VAV boxes, Fan Coil Units, Roof Top Units, Unit Ventalators, Split DX Systems, Heat Pumps, etc.
2. Performance: Inputs Provide software selectable universal inputs. Analog inputs - shall have the following minimum level of performance: 10 bit A to D resolution; manage thermistors with an accuracy of: ±0.9oF, and a Potentiometer. For VAV Applications provide a differential pressure input sensor built in to the controller with a control range of .01" to 1.25" H20 velocity pressure.
3. Output – Analog outputs shall have the following minimum level of performance: Tri-mode Voltage of 0-10 VDC (linear), digital 0-12 VDC (off/on) or PWM. All analog

outputs shall be equipped with an auto-reset fuse. Output Resolution shall be a minimum 8 bits digital / analog converter. Digital outputs shall be provided with a minimum of a triac output rated at 24VAC and 1 amp. All analog outputs and power supply shall be fuse protected.

4. The ASCs except for the VAV shall be provided with an optimum start program internal to its control logic. The optimum start shall be activated by a time of day event signal from its NAC on the network.
    a. The ASC shall allow the use of its spare I/O as dumb I/O to be shared over the network to Freely Programmable Controller (FPC) or NAC where a sequence of operation can be applied to the I/O. Such applications shall include but not be limited to exhaust fan control, heaters, light control, etc.

F. Freely Programmable Controllers (FPC):
1. Freely Programmable Controllers shall be a controller designed for more complex sequences of operations such as built up AHU's, central plant operations, electrical monitoring, and control and management for chillers, boilers and generators. These FPCs are to allow for the flexibility of custom control programming to meet the needed sequences of operation.
2. Performance – Each FPC shall have a minimum of 64K of Non-volatile Flash memory for control applications and 128K non-volatile flash memory for storage with an 8-bit processor at 10 mhz. The FPC shall have a minimum ambient operating temperature range of -0oC to 70oC or 32oF to 158oF. All connected points are to be updated at a minimum of one-second intervals.
3. Inputs – Analog inputs shall have the following minimum level of performance: 10-bit A to D resolution; manage thermistors with an accuracy of: ±0.9oF, platinum sensors with an accuracy of ±1.8oF, 0-10 VDC with Accuracy of ±0.5%, a 4-20 mA signal and a Potentiometer with an accuracy of ±0.5%.
4. Output – Analog outputs shall have the following minimum level of performance: Tri-mode Voltage of 0-10 VDC (linear), digital 0-12 VDC (off/on) or PWM. All outputs shall an auto reset fuse. Output Resolution shall be a minimum 8 bits digital / analog converter. Digital outputs shall be provided with a minimum of a 5-amp relay at 14VDC-24VAC. Where required provide for a manual override of the digital outputs built into the controller. All individual outputs and power supply shall be fuse protected. There shall be an LED status indicator on each of the outputs.
5. The FPC shall have the ability to share over the network with other controllers a minimum of 8 variable inputs and 8 variable outputs.
6. The FPC shall be provided with a diagnostic indicator light that when flashing signifies that the application program is running correctly.

2.4 MINIMUM POINTS

A. Air Handling Unit:
1. Outside air temperature.
2. Mixed air temperature.
3. Supply air temperature.
4. Supply air temperature reset.
5. Return air temperature.
6. Fan status.
7. Cooling/heating valve position (% of full open).
8. The following points are only required if required by control strategy.

9. Calculated total outside air flow (cfm).
10. Damper positions (% of full open).
11. Duct static pressure.
12. Fan speed (% of full speed).
13. Freeze protection status.
14. Alarms (temperature, flow).
15. Outside air humidity.
16. Humidity valve position (% of full open).
17.
18. NOTE: Existing campus weather station data is to be integrated by contractor and used for control functions of buildings and regional utility plants. However, University requires local outdoor air temperature sensor and humidity sensor to be located at each building for continuous reporting and use in control functions on loss of communications to AX supervisor.

B. Hot Water System:
1. Supply and return temperature.
2. Supply temperature reset.
3. Pump status (current sensor).
4. High/low temperature alarms.
5. The following points are only required if required by control strategy.
6. Secondary/tertiary supply and return temperature.
7. Secondary/tertiary flow (GPM).
8. Bridge flow (GPM).
9. Secondary/tertiary pump speed (% of full speed).
10. Return water temperature control valve (% of full open).
11. Secondary/tertiary loop differential pressure.

C. Chilled Water System:
1. Supply and return temperature.
2. Supply temperature reset.
3. Pump status (current sensor).
4. High/low temperature alarms.
5. The following points are only required if required by control strategy.
6. Secondary/tertiary supply and return temperature.
7. Secondary/tertiary flow (GPM).
8. Bridge flow (GPM).
9. Secondary/tertiary pump speed (% of full speed).
10. Return water temperature control valve (% of full open).
11. Secondary/tertiary loop differential pressure.

D. Metering for Chilled Water, Hot Water, and Power:
1. Output from building kilowatt-hour meter:
    a. Current and voltage for each phase and average of all three phases.
    b. kW for each phase and total of all three phases.
    c. Power factor for each phase and all three phases.
    d. KWH.
2. Output from BTU meter (flow, S&R temp, Rate, total BTU).

2.5 CONTROLS INSTRUMENTATION

A. Control Panels:
1. Panels shall have hinged doors and be marked with engraved labels. Panels used as a location for mounting control devices shall have a document holder located on the inside of the door.
2. Provide common keying for all panels.
3. Entrance and exit wiring should be on the panel sides.
4. All heat generating devices shall be located at the top of the panel.

B. Thermostats:
1. Space Thermostats:
   a. All room thermostats shall have exposed setpoint adjustment with internal stops or software stops for minimum and maximum setting initially set between 70 degrees and 74 degrees.
   b. All room thermostats in public areas will have concealed setpoint adjustments with blank cover.
   c. Insulated mounting bases on exterior walls.
   d. Accuracy to +/-0.5%.
   e. Each thermostat shall be capable of reporting the space temperature and setpoint.
2. Combined Temperature and Carbon Dioxide Sensors:
   a. Where indicated on plans, a combined temperature and carbon dioxide sensor shall be provided in a single package. Combined sensor shall be Telaire Airestat Model 5010 or as manufactured by Veris CDW/E series. Housing shall be blank with a momentary pushbutton for override of unoccupied operation. The carbon dioxide sensor shall be non-dispersive infrared type with an accuracy of ± 100 ppm or 7% of the reading (whichever is greater). Elevation correction adjustment and software for self-correction of drift to better than ± 10 ppm per year shall be incorporated.
   b. Temperature sensors shall be capable of being replaced without the need for controller re-calibration. Temperature sensors shall accordingly have manufactured space temperature and setpoint signal precision tolerances of no greater than 1°F.
3.
4. Temperature Sensors:
   a.
   b. All internal temperature sensors for air handler and energy recover unit temperature readings shall be temperature averaging cable that spans across the full face of the associated coil. Install per manufacturer requirements.

C. Labels and Tags:
1. Provide labels for all field devices including sensors, meters, transmitters and relays. Labels shall be plastic laminate and located adjacent to the device.
2. Labels of field devices (both locally and software ID's) shall be associated with their respective air handler, boiler, chiller, etc.

PART 3 - EXECUTION

3.1 INSTALLATION AND SUPERVISION

A. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the temperature control system manufacturer or its exclusive factory authorized installing contracting field office (representative). The installing office shall have a minimum of five years of installation experience with direct digital control systems. Supervision, calibration and checkout of the system shall be by the employees of the local exclusive factory authorized temperature control contracting field office (branch or representative).

3.2 INSTALLATION

A. Control Wiring:
   1. Interlock control wiring shall be a minimum of No. 18 gauge. All electrical work performed in the installation of the BAS/ATC system as described in this specification shall be per the National Electrical Code (NEC) and per applicable state and local codes. All wiring shall be installed in conduit unless specified otherwise. Where exposed, conduit shall be run parallel to building lines properly supported and sized at a maximum of 40% fill. In no cases shall field installed conduit smaller than 1/2" trade size be allowed. All electrical work shall comply with Division 16000 of these specifications.
   2. Where specified, Class 2 wires in approved cables not in raceway may be used provided that:
      a. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit).
      b. All cables shall be UL listed for application, i.e., cables used in plenums shall be UL listed specifically for that purpose.
      c. Wiring shall be run parallel along a surface or perpendicular to it, and bundled, to achieve a neat and workmanlike result.
   3. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
   4. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
   5. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.
   6. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with other sections of this specification and local codes.
   7. Size of conduit and size and type of wire shall be the design responsibility of the Control System Contractor, in keeping with the manufacturer's recommendation and NEC.
   8. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.
   9. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used.

10. Where power for controls are not specifically indicated on Electrical Drawings, BAS Contractor shall be responsible for programmable and panel controller power to closest 120 volt breaker.
11. The control wiring for the control transformers shall be the responsibility of the controls contractor from a dedicated voltage source provided by the electrical contractor.

3.3 ON-SITE TESTING

A. When installation is complete, the controls contractor shall perform the following:
   1. A field calibration of all sensors.
   2. Verification of each control point by comparing the control command and the field device.
   3. Documentation of results shall be provided to the Owner prior to final acceptance.

3.4 FUNCTIONAL TESTING

A. The controls contractor shall perform functional test that controls are installed, adjusted and operate as required by the drawings and specifications. This functional test shall be documented and may be conducted in conjunction with the training of Owner's personnel. The documentation shall identify the item, the person performing the functional test, date. Provide adequate notice to Owner for optional witnessing of functional testing. Typical items to be tested as follows:

B.

Item Demonstrated	Controls Contractor (Name)	Convention Center Representative (Signature)	Date
Disconnect one DDC device from the NAC to demonstrate that a single device failure will not disrupt peer-to-peer communication.			
Manually generate alarms at all points and demonstrate that the workstation(s) receive the alarms			
Calibration has been performed on at least sensors			
Point-to-point verification of all points. Include labeling of points.			
Sequence of operation for the air handling units including economizer cycle, reset, start/stop,			
Sequence of operation for Co2 control functions			
Sequence of operation for the chilled water system.			

Item Demonstrated	Controls Contractor (Name)	Convention Center Representative (Signature)	Date
Sequence of operation of the HVAC controls system during a fire alarm			
Fail safe operation of AHUs, chilled water system, hot water system, and fan coil units.			
Response to upset conditions and change of setpoint for selected systems			

3.5 ACCEPTANCE TESTING

A. Point Verification:
1. To verify end-to-end operation of the system, the Contractor shall provide a hard copy of an All Points Summary Listing to the Owner of each part or system to be placed in warranty by the Owner. Sequence Verification during acceptance testing period.
2. The Contractor shall notify the Owner's representative of systems which perform all specified sequences. The engineer shall have the option of verifying all sequences of operation and place the system into warranty acceptance test.
3. The warranty acceptance test shall be of 7 days duration and the system shall perform as follows:
    a. During the seven days, the BAS system shall not report any system diagnostics from the subsystem under test.
    b. The subsystem shall be performance verified as operating using temporary trends of each control loop.
    c. During the occupied periods, BAS control loops under test shall maintain control of the process variable within the following scales:
        1) Duct Static Pressure: +0.3 WC
        2) Pump Head Pressure: +10% of control range
        3) Duct Temperature Loops: +2.0F
        4) Room Temperature: +1.0F
        5) Pipe Temperature: +2.0F
        6) Duct Humidity: +2x rate error of Humidity Transmitter
        7) Room Humidity: +2x rate error of Humidity Transmitter
        8) Carbon Dioxide PPM: ± 100 ppm

3.6 OWNER TRAINING

A. General: Owner training shall be executed in four phases. The System Integrator will provide at no cost to the owner, Phase I, Phase II, Phase III and Phase IV training classes. A proposed training agenda will be submitted to the university Facility Mechanical Engineer in writing and approved by the Facility Mechanical Engineer before the training takes place.
1. The first phase shall take place at the customer job site and will be scheduled at a time preceding owner acceptance. The purpose of the training is to provide an introduction and an overview of the FMS, and ensure POT is operational and functional with installed controllers.

2. The second phase of training shall be a follow-up training to address specific building system and questions of the operators. Training shall take place at the customer job site and will include a site-specific walk through and hands on site-specific instruction. Completion of this training shall be a condition of system acceptance.
3. Phase III and Phase IV training shall be provided as a follow-up and enrichment to the introductory and site-specific training.

3.7 PHASE I – ON SITE TRAINING

A. This training will give the operator with little or no experience with the FMS an introduction to:
1. Building automation fundamentals.
2. System architecture and functions as they pertain to the site.
3. System access using the Browser User Interface and FMS software.
4. Basic software controller programming and tuning.
5. Editing parameters such as set points and schedules.
6. Developing trends and day to day system monitoring.
7. The complete range of hardware and software products.
8. Building walk-thru.

3.8 PHASE II – ON SITE TRAINING

A. The manufacturer and the controls contractor shall provide 6 hours of on-site training in the maintenance and operation of the installed system for up to (4) personnel. The training shall be documented, and a syllabus and O&M manuals shall be submitted and approved by Facilities Operations 2 weeks prior to the training. The training should include the following:
1. HVAC systems layout including the locations of air handlers, DDC controllers, VAV boxes, pumps. This will include a walk-thru at the building.
2. Review of O&M manual and control system as-builts:
   a. Using As-Built documentation, Sequences of operation, control drawings, input/output summaries.
   b. Field sensor and actuator location and maintenance.
   c. Field controller location and maintenance.
   d. FMS hardware operation and maintenance.
   e. FMS software site specific capabilities.
   f. Troubleshooting tools.
3. Sequence of operations for each control loop.
4. Demonstration and turnover to owner of POT.
   a. Logon procedure.
   b. Use of laptop Lonworks tools or NAC plug-ins to configure ASCs or Program FPCs.
   c. Password requirements.
5. Operation and troubleshooting including:
   a. Modification of ASC or FPC setpoints, parameters, etc.
   b. Calibration and adjustment.
   c. Trending.
   d. Hands on training in the troubleshooting and replacement of components including sensors, transmitters, control valves and actuators. Contractor shall have examples of each component and demonstrate measurement of input and output signals, and any operator adjustments available.

e. DDC controller functions and operation.

B. This phase of training shall be a minimum of 6 hours.

3.9 PHASE III – ON SITE TRAINING

A. No later than 6 months and no earlier than 4 months from building acceptance, the SI will repeat Phase I and Phase II training. Training to be consolidated into one 4-hour session.

3.10 PHASE IV – ON THE JOB TRAINING

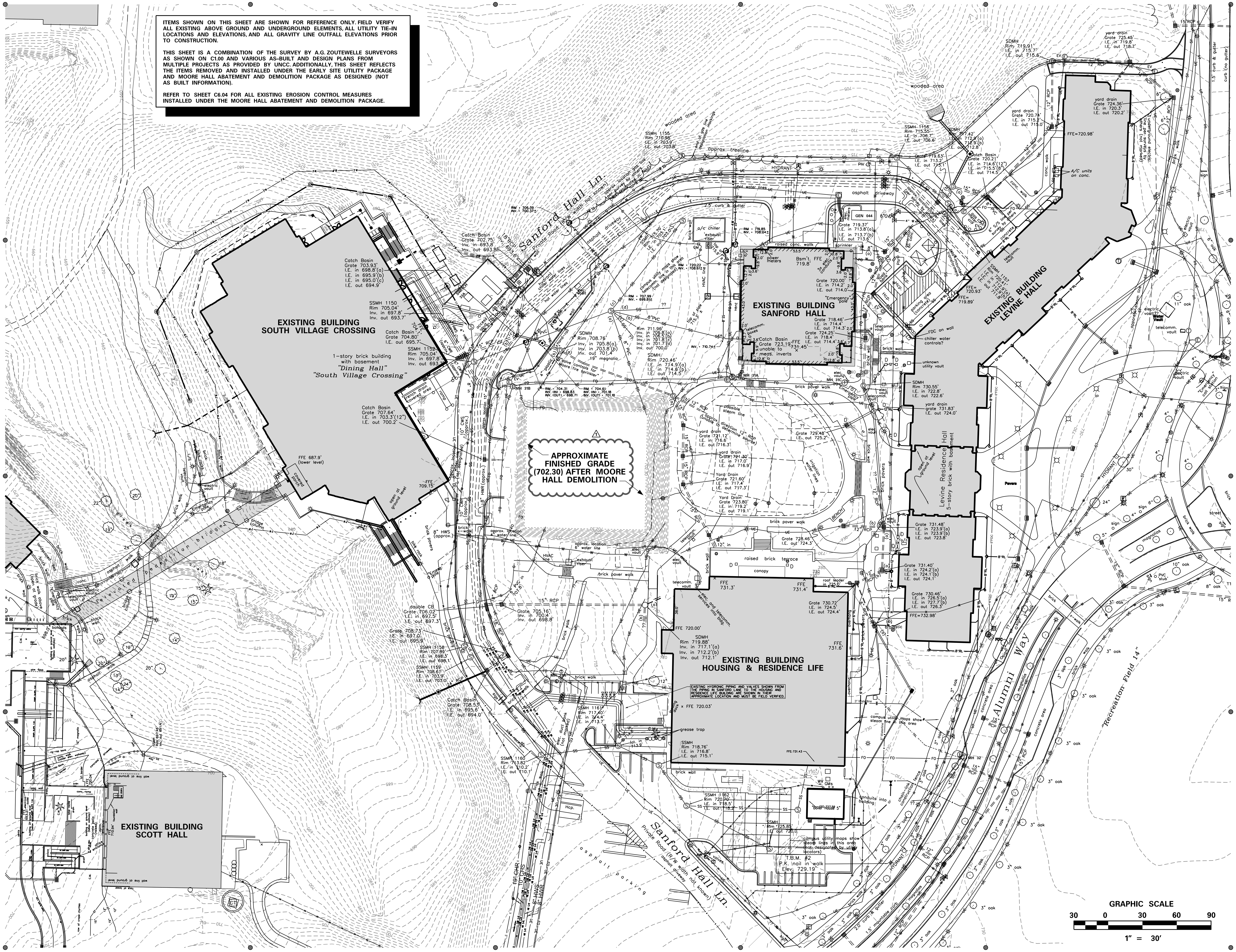
A. SI and/or controls contractor shall coordinate all site visits and provide opportunity for university personnel to receive OJT during warranty work. Additionally, provide 2 days of OJT control loop tuning with owner utilizing owner POT.

B. The DDC contractor shall provide an additional 4hours on-site training session twelve (12) months after project completion. The purpose of the session will be to review any operational problems that have developed. In addition, the contractor will lead Facilities Operations personnel through a comprehensive annual preventative maintenance of the controls system. This shall be scheduled at least one (1) month in advance.

3.11 WARRANTY ACCESS

A. The Owner shall grant the Contractor, reasonable access to the BAS system during the warranty period. The owner shall provide at no cost to the contractor web browser access (VPN) for remote service and troubleshooting during warranty period.

END OF SECTION 230900



GRAPHIC SCALE

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1" = 30'

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Jenkins • Peer *Architects*

112 South Tryon Street, Suite 1300
Charlotte, North Carolina 28284
(t) 704/372-6665

KWK ARCHITECTS

103 West Lockwood, Suite 218
St. Louis, Missouri 63119
(t) 314/942-8810

STANLEY D. LINDSEY & ASSOC. ENGINEERING, PA
Civil Engineer
NC License # C-1863
1437 Harding Place, Suite 201
Charlotte, North Carolina 28204
(t) 704/333-3122

SKA CONSULTING ENG., PA
Structural Engineer
NC License # F-0508
4651 Charlotte Park Drive, Suite 150
Charlotte, North Carolina 28217
(t) 704/424-9663

OPTIMA ENGINEERING, PA
Mechanical, Electrical, Plumbing + Fire Protection Engineering
NC License # C-0914
1927 South Tryon Street, Suite 300
Charlotte, North Carolina 28203
(t) 704/338-1292

LANDDESIGN, INC.
Landscape Design
NC License # C-0658
223 North Graham Street
Charlotte, NC 28202
(t) 704/376.7777

NORTH CAROLINA PROFESSIONAL SEAL 18175 ENGINEER JEFFREY L. SMITH 08.26.19

UNC CHARLOTTE

Charlotte, NC

RESIDENCE HALL PHASE XVI

SCO ID: 18-18333-02A

TAG	DESCRIPTION	DATE
1	ADDENDUM 1	08/26/19

Project: JPA:18NCC016; SDL 18018
Drawn By: S.H.D.
Checked By: J.I.S.
Date: 08/06/19

EXISTING CONDITIONS

BID SET

C1.01

SITE HORIZONTAL CONTROL:
REFER TO SHEET C1.00 FOR
SURVEY BENCHMARKS

SITE LEGEND

BL	BLUE LIGHT EMERGENCY PHONE
SL	STREET LIGHT POLE (PARKWAY LIGHTING)
PL	PEDESTRIAN SCALE LIGHT POLE (STYLE OPL1)
BN	BENCH PAD
T/R	TRASH AND RECYCLING RECEPTACLES PAD
FH	FIRE HYDRANT
PIV	POST INDICATOR VALVE (FIRE SERVICE)
FDC	FIRE DEPARTMENT CONNECTION

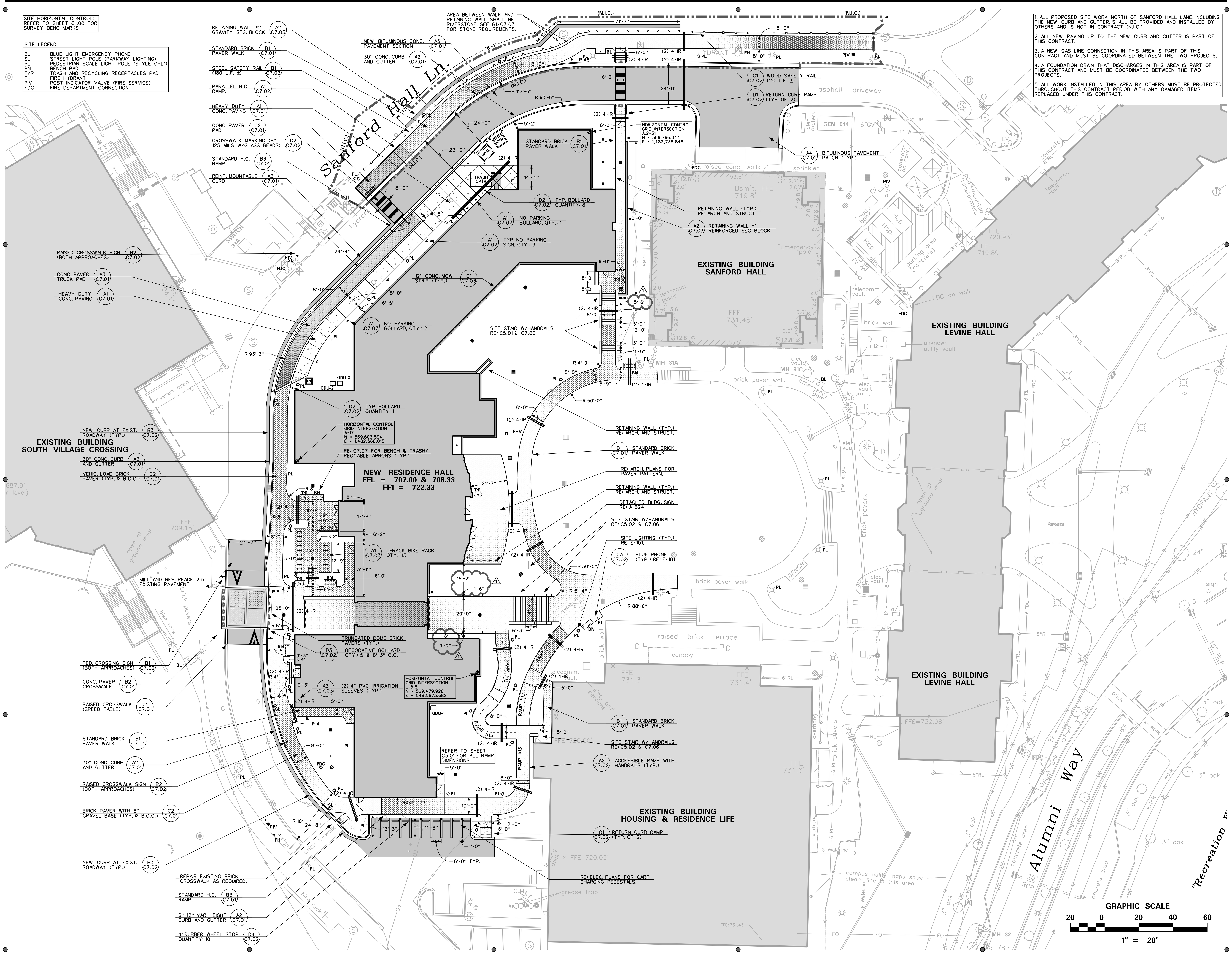
1. ALL PROPOSED SITE WORK NORTH OF SANFORD HALL LANE, INCLUDING THE NEW CURB AND GUTTER, SHALL BE PROVIDED AND INSTALLED BY OTHERS AND IS NOT IN CONTRACT (N.I.C.)

2. ALL NEW PAVING UP TO THE NEW CURB AND GUTTER IS PART OF THIS CONTRACT.

3. A NEW GAS LINE CONNECTION IN THIS AREA IS PART OF THIS CONTRACT AND MUST BE COORDINATED BETWEEN THE TWO PROJECTS.

4. A FOUNDATION DRAIN THAT DISCHARGES IN THIS AREA IS PART OF THIS CONTRACT AND MUST BE COORDINATED BETWEEN THE TWO PROJECTS.

5. ALL WORK INSTALLED IN THIS AREA BY OTHERS MUST BE PROTECTED THROUGHOUT THIS CONTRACT PERIOD WITH ANY DAMAGED ITEMS REPLACED UNDER THIS CONTRACT.



Jenkins • Peer Architects
112 South Tryon Street, Suite 1300
Charlotte, North Carolina 28284
(t) 704/372-6665

KWK ARCHITECTS
103 West Lockwood, Suite 218
St. Louis, Missouri 63119
(t) 314/942-8810

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Charlotte, NC 28202
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NORTH CAROLINA PROFESSIONAL ENGINEER 08/26/19 JEFFREY I. SMITH

UNC CHARLOTTE

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RESIDENCE HALL PHASE XVI

SCO ID: 18-18333-02A

TAG	DESCRIPTION	DATE
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Project: JPA:18NCC016; SDL 18018
Drawn By: S.H.D.
Checked By: J.I.S.
Date: 08/06/19

SITE PLAN

BID SET

C3.00

23-AUG-2019 09:55
P:\2018\2018.03 UNCC Phase XVI\CADD Files\xviC300.dgn

RADIUS: 1/8" RADIUS

STANDARD WIDTH: 3"

STANDARD LENGTH: APPROX. 6"

MATERIAL: CAST SILICON BRONZE

FINISH: BROWN PATINA FINISH

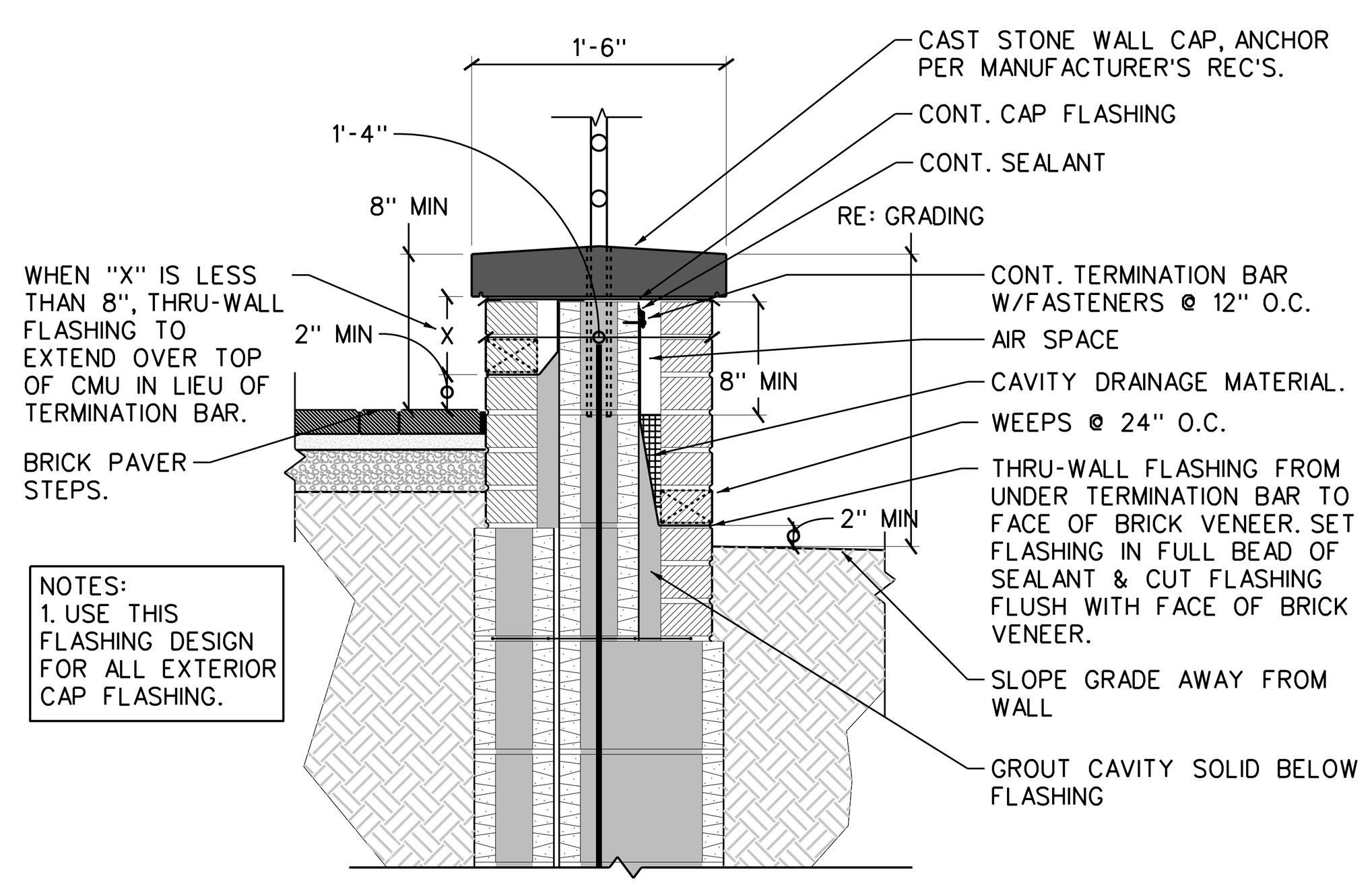
ANCHORING: TWO OFFSET BLIND HOLES FOR 2" SMART PINS PLUS. USE IN CONJUNCTION WITH TWO PART IMPACT RESISTANT EPOXY.

PRODUCT SPACING: 12"-18" FROM ENDS/CORNERS AND APPROXIMATELY 36" +/- 6". WHEN WORKING ON PRECAST BLOCKS/CAPTSONE OR STONE, LAYOUT WILL BE DICTATED BY UNIFORMITY OF SPACING RELATIVE TO GROUT LINES. DO NOT ATTACH AT GROUT LINES OR EXPANSION JOINTS.

NOTE:
1. CONTRACTOR TO SUBMIT COMPLETE SCHEDULE AND SHOP DRAWING OF SKATE STOPPERS PRIOR TO CONSTRUCTION FOR APPROVAL BY OWNER AND LANDSCAPE ARCHITECT.

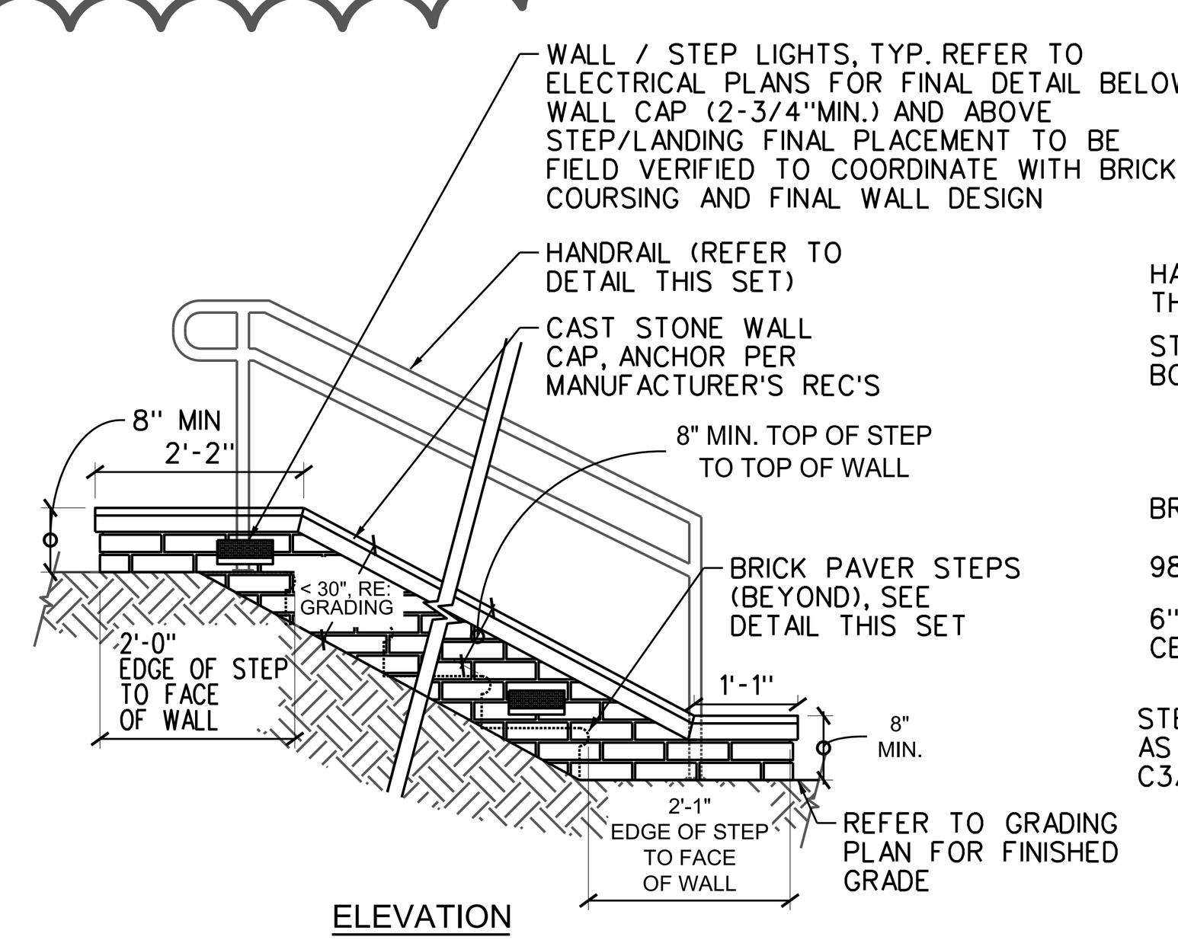
D1 Skate Deterrent - Wall Cap

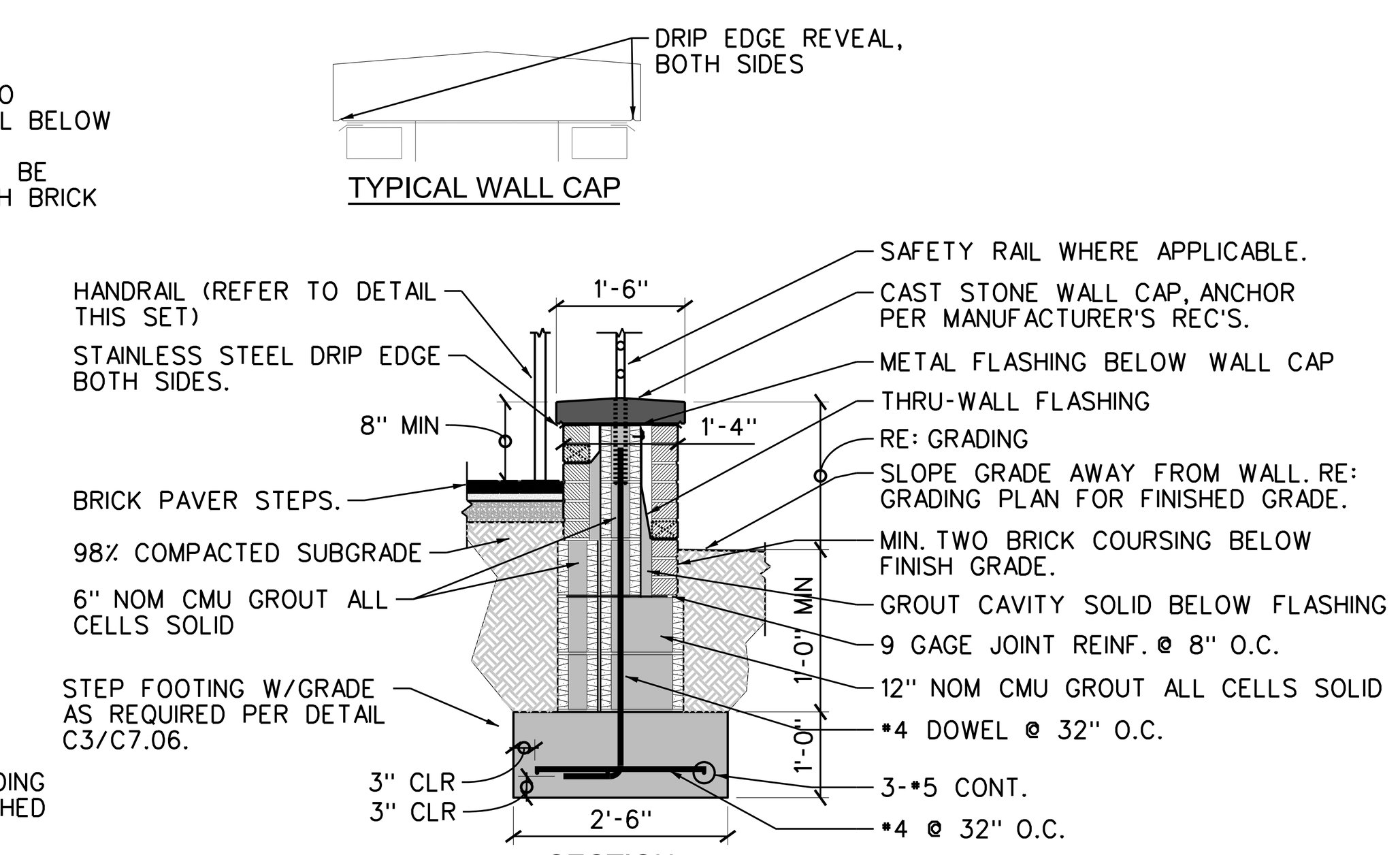
No Scale



C1 Typ. Wall Cap Flashing

No Scale

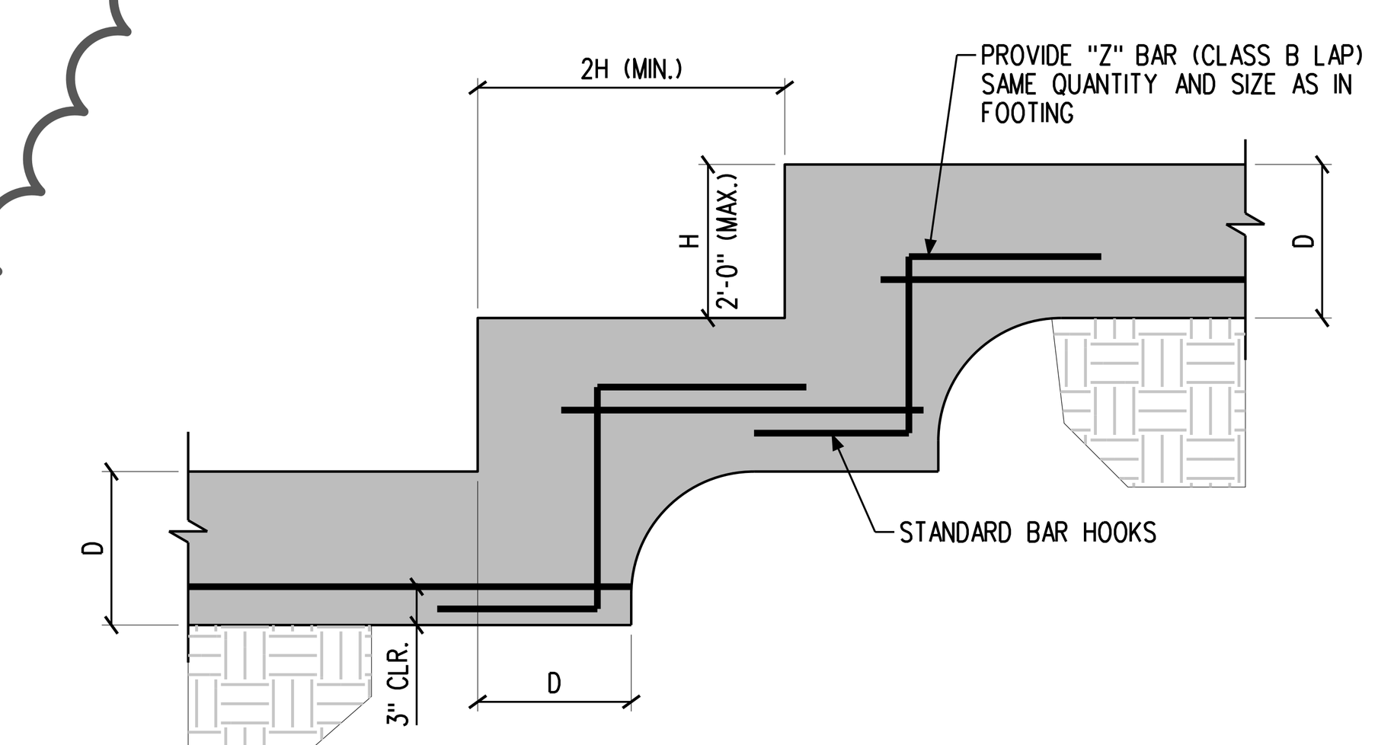




NOTES:
1. REFER TO SECTION DETAILS THIS SET FOR WALL CAP DETAILS.
2. CONCRETE TO BE 3600 PSI@ 28 DAYS UNLESS OTHERWISE SPECIFIED BY STRUCTURAL ENGINEER.
3. STRUCTURAL ENGINEER TO STAMP AND SEAL ALL WALLS OVER 30" IN (VERTICAL).

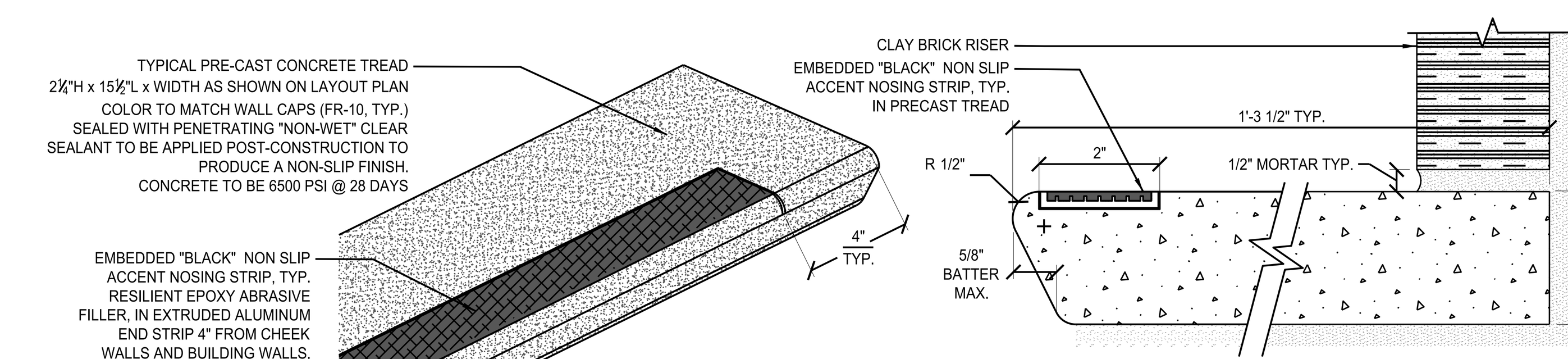
C2 Masonry Cheek Wall

No Scale



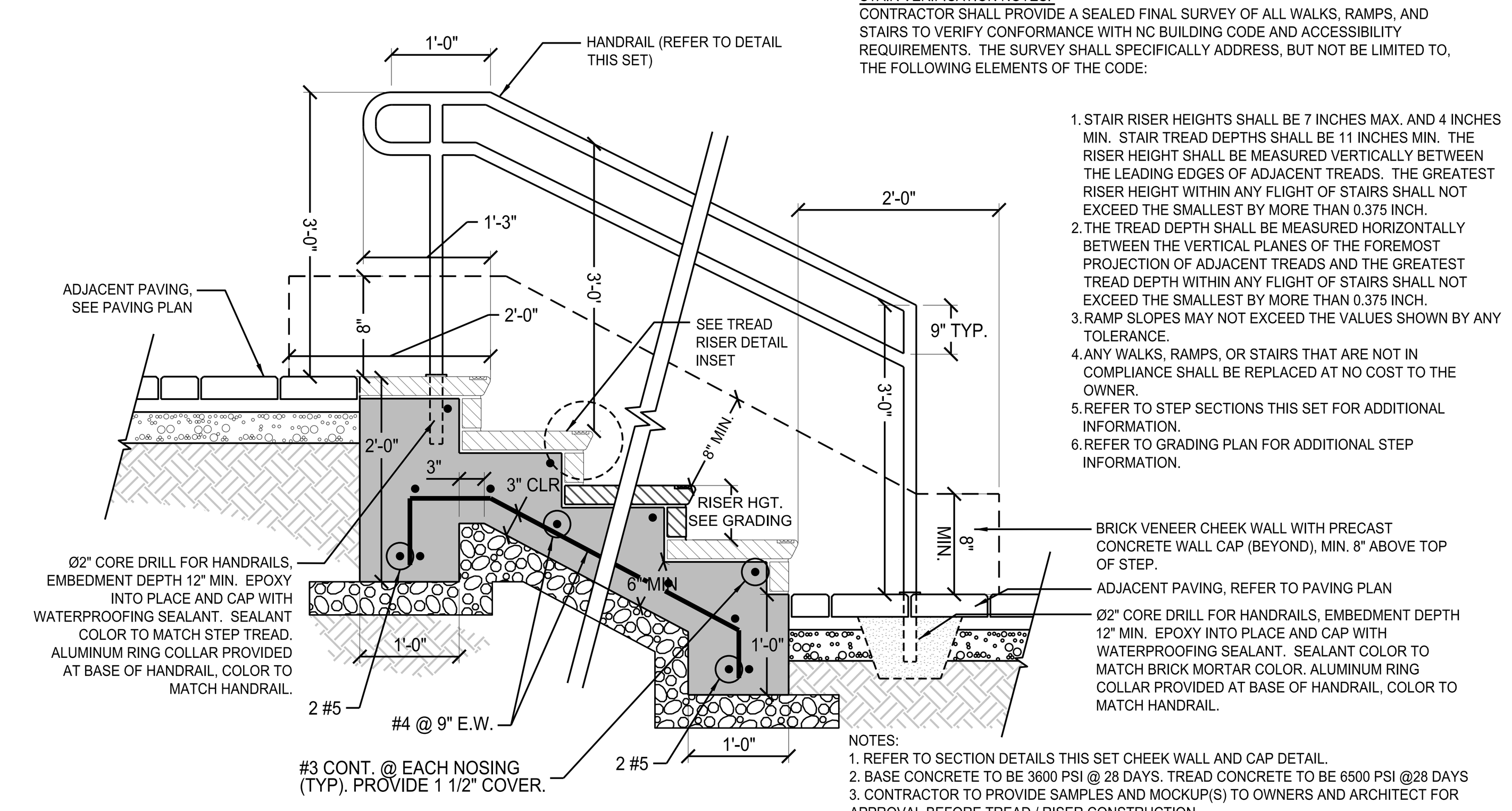
C3 Typ. Stepped Footing

No Scale



STAIR VERIFICATION NOTES:
CONTRACTOR SHALL PROVIDE A SEALED FINAL SURVEY OF ALL WALKS, RAMPS, AND STAIRS TO VERIFY CONFORMANCE WITH NC BUILDING CODE AND ACCESSIBILITY REQUIREMENTS. THE SURVEY SHALL SPECIFICALLY ADDRESS, BUT NOT BE LIMITED TO, THE FOLLOWING ELEMENTS OF THE CODE:

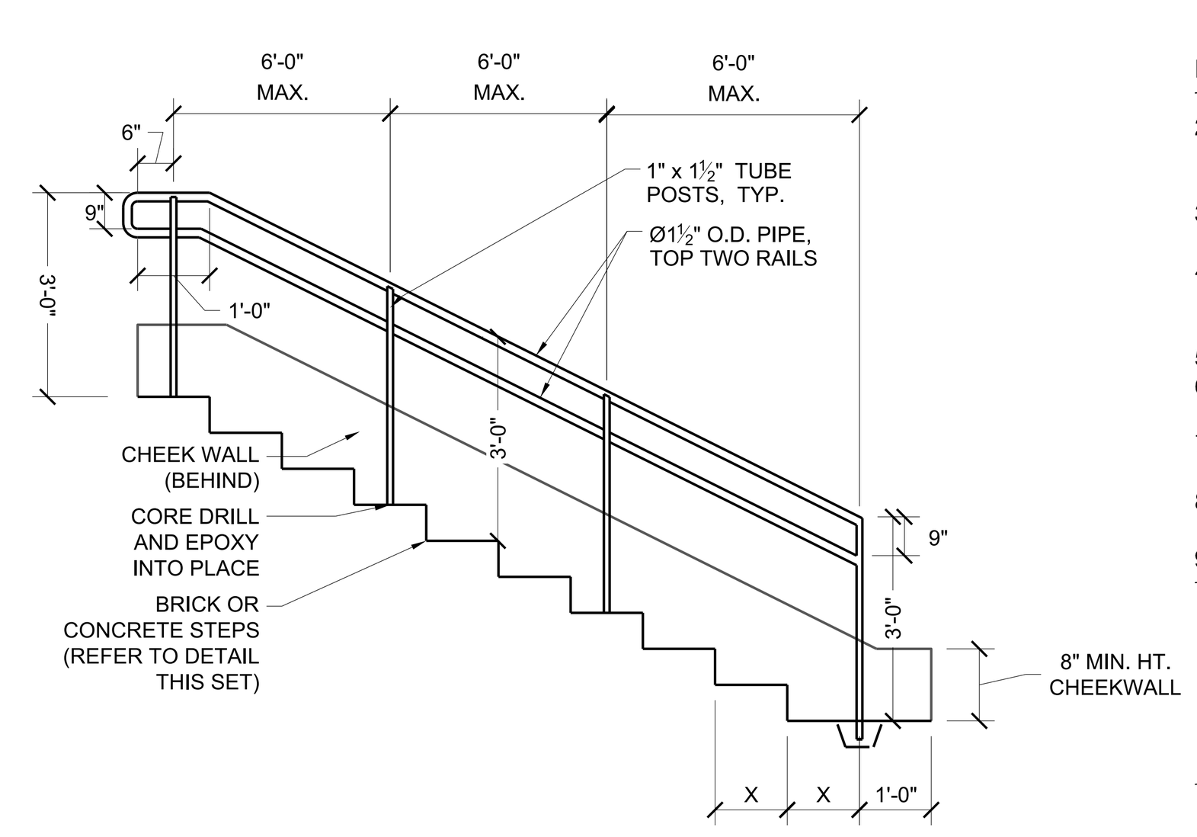
1. STAIR RISER HEIGHTS SHALL BE 7 INCHES MAX. AND 4 INCHES MIN. STAIR TREAD DEPTHS SHALL BE 11 INCHES MIN. THE RISER HEIGHT SHALL BE MEASURED VERTICALLY BETWEEN THE LEADING EDGES OF ADJACENT TREADS. THE GREATEST RISER HEIGHT WITHIN ANY FLIGHT OF STAIRS SHALL NOT EXCEED THE SMALLEST BY MORE THAN 0.375 INCH.
2. THE TREAD DEPTH SHALL BE MEASURED HORIZONTALLY BETWEEN THE VERTICAL PLANES OF THE FOREMOST PROJECTION OF ADJACENT TREADS AND THE GREATEST TREAD DEPTH WITHIN ANY FLIGHT OF STAIRS SHALL NOT EXCEED THE SMALLEST BY MORE THAN 0.375 INCH.
3. RAMP SLOPES MAY NOT EXCEED THE VALUES SHOWN BY ANY TOLERANCE.
4. ANY WALKS, RAMPS, OR STAIRS THAT ARE NOT IN COMPLIANCE SHALL BE REPLACED AT NO COST TO THE OWNER.
5. REFER TO STEP SECTIONS THIS SET FOR ADDITIONAL INFORMATION.
6. REFER TO GRADING PLAN FOR ADDITIONAL STEP INFORMATION.



NOTES:
1. REFER TO SECTION DETAILS THIS SET CHEEK WALL AND CAP DETAIL.
2. BASE CONCRETE TO BE 3600 PSI @ 28 DAYS. TREAD CONCRETE TO BE 6500 PSI @28 DAYS
3. CONTRACTOR TO PROVIDE SAMPLES AND MOCKUP(S) TO OWNERS AND ARCHITECT FOR APPROVAL BEFORE TREAD / RISER CONSTRUCTION.

B3 Site Steps

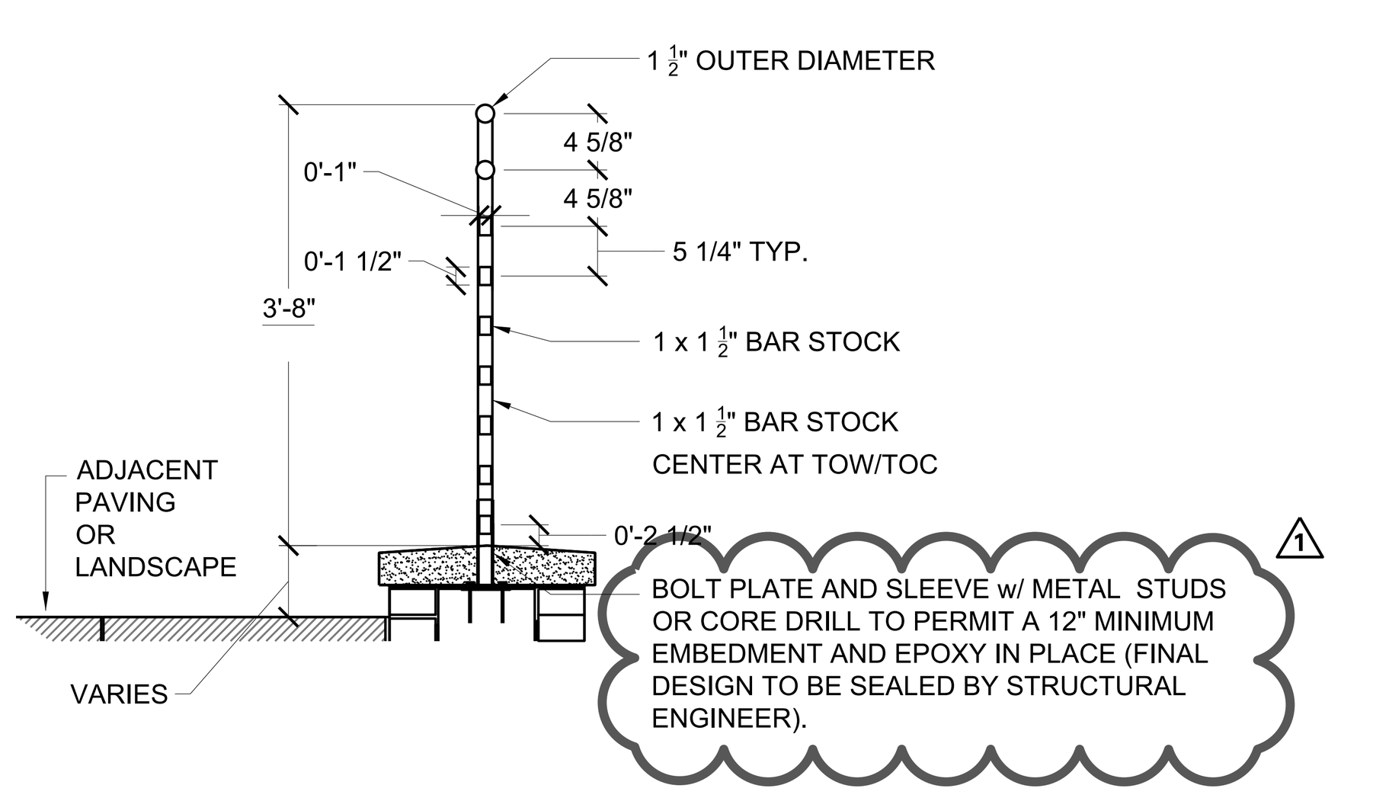
No Scale



NOTES:
1. NUMBER OF RISERS VARIES; REFER TO GRADING PLAN.
2. HANDRAIL SHALL HAVE 1 COAT PRIMER AND 2 COATS DEVOE ALKYD ENAMEL MALAGA GREEN DEVOE #1UM40A.
3. HANDRAIL SHALL BE CONTINUOUS METAL FROM TOP OF STEP TO BOTTOM OF STEP.
4. MAXIMUM SPACE BETWEEN POSTS SHALL BE 6'–0". GRIPPING SURFACE SHALL BE UNINTERRUPTED BY ANY CONSTRUCTION ELEMENTS OR OBSTRUCTIONS.
5. HANDRAILS SHALL NOT ROTATE WITHIN THEIR FITTINGS.
6. CLEAR SPACE BETWEEN THE HANDRAIL AND ANY WALL OR STRUCTURE SHALL BE 1 1/2".
7. ALL SITE HANDRAILS TO BE FABRICATED WITH CONTINUOUS WELDS, GROUND SMOOTH.
8. ALL HANDRAILS TO COMPLY TO CURRENT ADA STANDARDS FOR ACCESSIBLE DESIGN.
9. REFER TO CHEEK WALL AND CAP DETAIL THIS SET.
10. HANDRAIL SHALL BE SET WITH A 2" DIA. CORE DRILL AND EMBEDDED INTO PLACE AT A MINIMUM DEPTH OF 12". EPOXY INTO PLACE AND CAP WITH WATERPROOFING SEALANT. SEALANT COLOR TO MATCH BRICK MORTAR COLOR. ALUMINUM RING COLLAR PROVIDED AT BASE OF HANDRAIL, COLOR TO MATCH HANDRAIL.
11. ALL HANDRAILS TO BE GALVANIZED STEEL UNLESS OTHERWISE APPROVED BY OWNER.

B1 Handrail at Site Steps

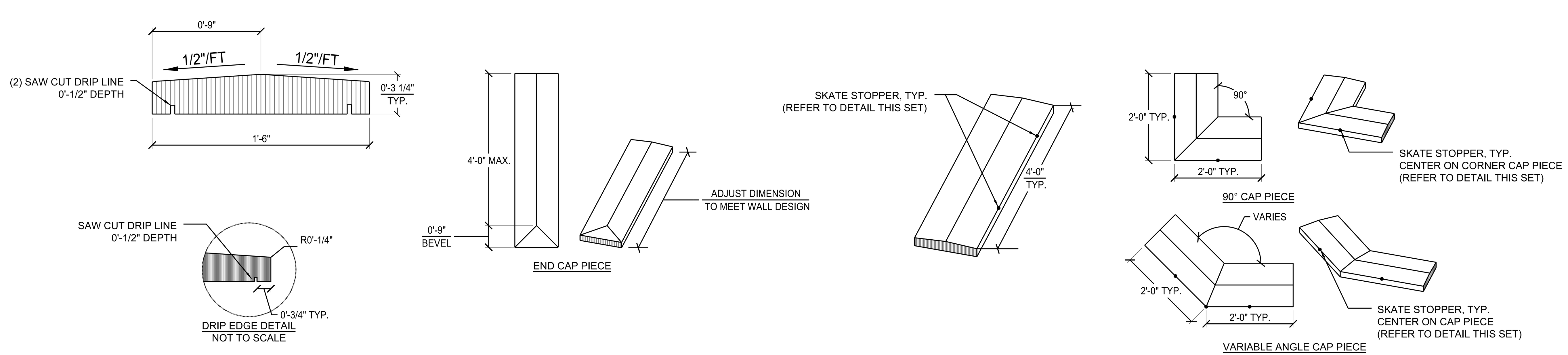
No Scale

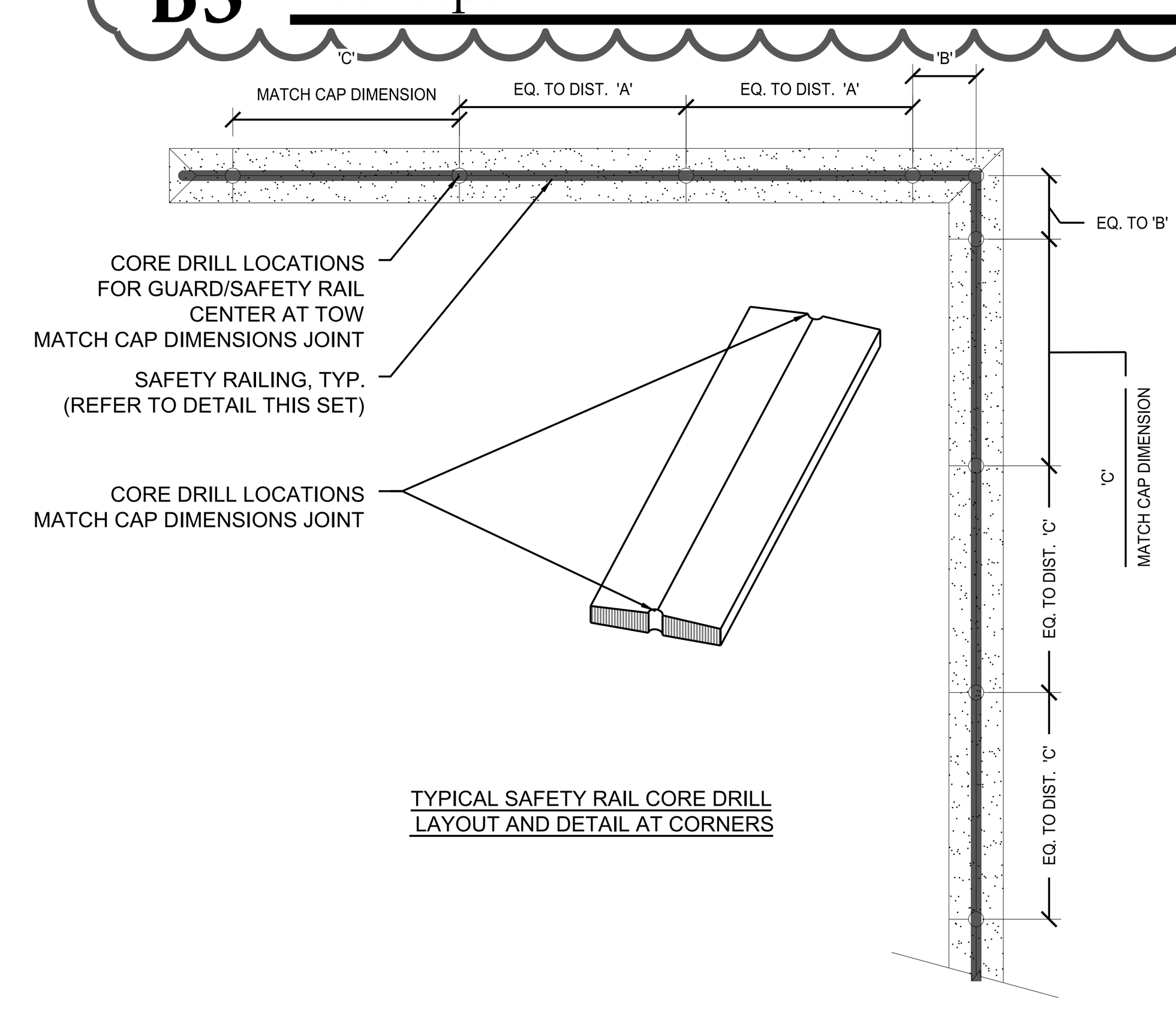


NOTES:
1. PAINT TO MATCH DEVOE PAINT COLOR MALAGA GREEN 1UM40A, PMS 5605 COLOR CODE.
2. MAXIMUM SPACE BETWEEN POSTS SHALL BE 8'-0".
3. ALL SITE GUARDRAILS/HANDRAILS TO BE FABRICATED WITH CONTINUOUS WELDS, GROUND SMOOTH.
4. REFER TO CAP DETAIL FOR TYPICAL CASTING DETAIL AT SAFETY RAIL POSTS.
5. ALL GUARDRAILS/HANDRAILS TO COMPLY TO CURRENT ADA STANDARDS.

B2 Safety Rail at Top of Wall/Curb

No Scale





NOTES:
1. CAP TO BE INSTALLED PER MANUFACTURER'S SPECIFICATIONS.
2. FOR SKATE STOPPER DETAIL AND INSTALLATION REFER TO DETAIL THIS SET.
3. CONTRACTOR TO SUBMIT A COMPLETE SCHEDULE OF PRECAST CAP PIECES FOR REVIEW BY OWNER AND ARCHITECT PRIOR TO CONSTRUCTION AND COORDINATION WITH GUARD/SAFETY RAILING.
4. CONTRACTOR TO SUBMIT SHOP DRAWINGS AND MOCKUP OF CAP COLOR AND FINISH TO ARCHITECT BEFORE BEGINNING OF CONSTRUCTION FOR APPROVAL AND BEFORE BEING RELEASED TO ORDER MATERIALS.
5. ALL JOINTS TO BE PERPENDICULAR TO CAP EDGE, FACE OF WALL, AND STRAIGHT . ALL NON UNIFORM CUTS (ASKEW, CROOKED, "ZIGZAGGED", ETC.) WILL BE REJECTED AND CAP WILL NEED TO BE REPLACED AT NO COST TO THE OWNER.
6. SAFETY RAIL POST LAYOUT TO MATCH CAP JOINT LOCATIONS. GENERAL INTENT IS TO MINIMIZE PENETRATIONS THROUGH CAP AND CO-LOCATE JOINTS AND POSTS. (CONTRACTOR MAY REFER TO UNC-CHARLOTTE CONE PLAZA CAP AND POST CO-LOCATION).
7. CONTRACTOR TO VERIFY ALL CAP DIMENSIONS (INCLUDING DRIP EDGE PLACEMENT) WITH FINAL CONSTRUCTION OF STRUCTURAL WALL AND ARCHITECTURAL VENEER BEFORE ORDERING AND CONSTRUCTION.

A1 Precast Wall Cap (Typical)

No Scale

Jenkins • Peer Architects
112 South Tryon Street, Suite 1300
Charlotte, North Carolina 28284
(t) 704/372-6665

KWK ARCHITECTS
103 West Lockwood, Suite 218
St. Louis, Missouri 63119
(t) 314/942-8810

STANLEY D. LINDSEY & ASSOC. ENGINEERING, PA
Civil Engineer
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Mechanical, Electrical, Plumbing + Fire Protection Engineering
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LANDDESIGN, INC.
Landscape Design
NC License # C-0658
223 North Graham Street
Charlotte, NC 28202
(t) 704/376.7777

NORTH CAROLINA PROFESSIONAL ENGINEER 16175 JEFFREY I. SMITH 08-26-19

UNC CHARLOTTE

Charlotte, NC

RESIDENCE HALL PHASE XVI

SCO ID: 18-18333-02A

TAG	DESCRIPTION	DATE

Project: JPA:18NCC016; SDL 18018
Drawn By: S.H.D.
Checked By: J.I.S.
Date: 08/06/19

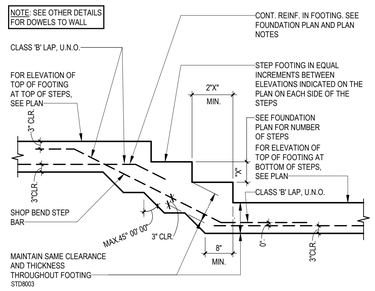
SITE DETAILS

NORTH

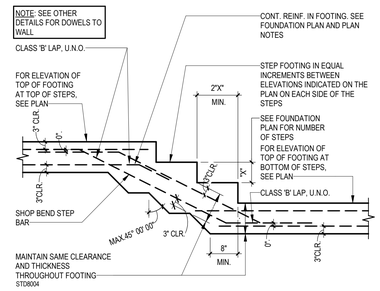
BID SET

C7.06

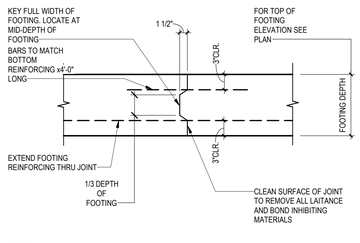
23-AUG-2019 10:04
P:\2018\2018.03 UNCC Phase XVI\CADD Files\xxC706.dgn



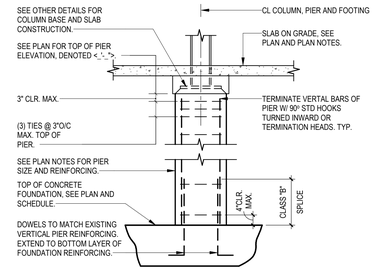
1 S-801 **STEPPED WALL FOOTING**
1/2" = 1'-0"



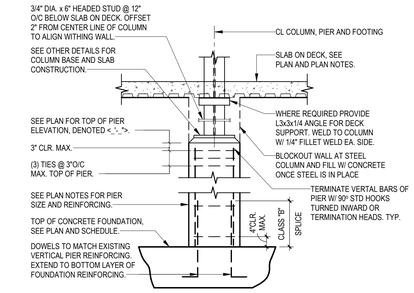
2 S-801 **STEPPED WALL FOOTING W/TOP AND BOTT. STEEL**
1/2" = 1'-0"



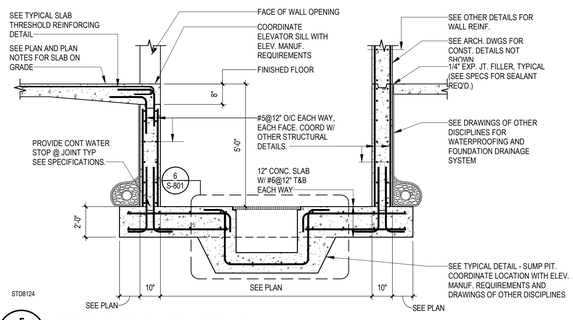
3 S-801 **FOOTING CONSTRUCTION JOINT**
1" = 1'-0"



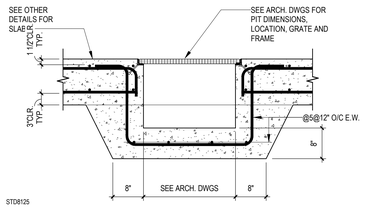
4 S-801 **COLUMN PIER**
1/2" = 1'-0"



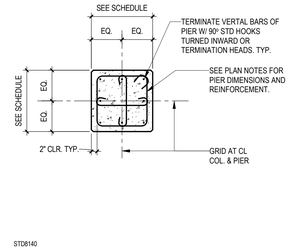
17 S-801 **COLUMN PIER AT WALL**
1/2" = 1'-0"



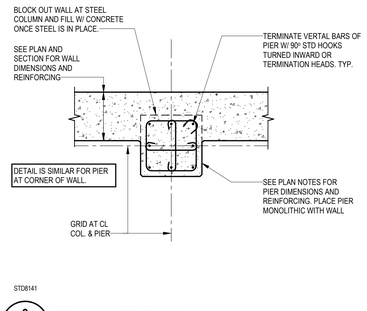
5 S-801 **SECTION THROUGH ELEVATOR PIT**
1/2" = 1'-0"



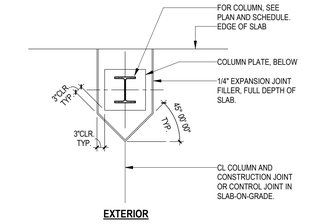
6 S-801 **ELEVATOR SUMP PIT**
3/4" = 1'-0"



7 S-801 **COLUMN PIER**
1/2" = 1'-0"

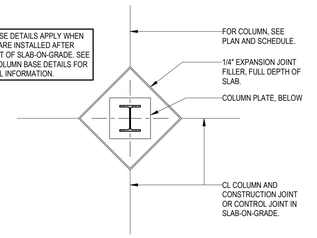


8 S-801 **COLUMN PIER AT WALL**
1/2" = 1'-0"



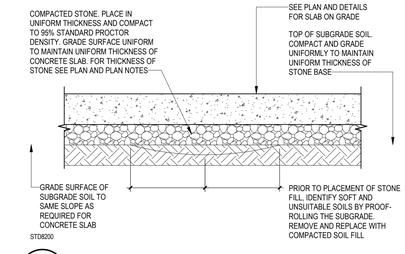
EXTERIOR

NOTE: THESE DETAILS APPLY WHEN COLUMNS ARE INSTALLED AFTER PLACEMENT OF SLAB-ON-GRADE. SEE TYPICAL COLUMN BASE DETAILS FOR ADDITIONAL INFORMATION.

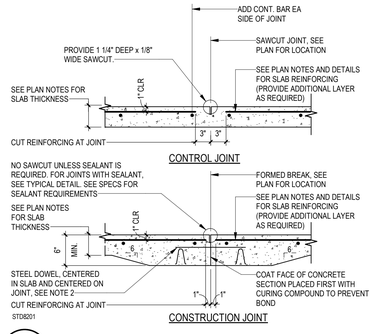


INTERIOR

9 S-801 **COLUMN ISOLATION JOINT**
1/2" = 1'-0"



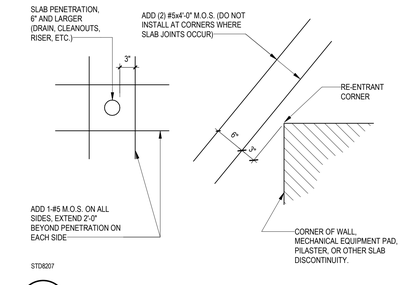
10 S-801 **SLAB-ON-GRADE SUBGRADE PREPARATION**
1" = 1'-0"



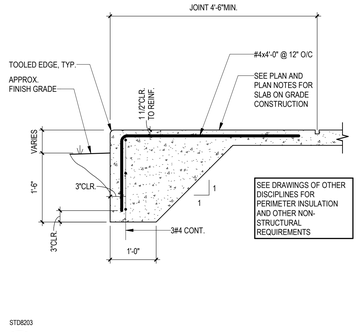
SLAB-ON-GRADE JOINT NOTES:
1. LOCATE JOINTS IN CONCRETE SLAB AS SHOWN ON FOUNDATION PLAN.
2. SLAB JOINT DOWELS:
   A. PROVIDE 3/4"x16" SMOOTH ROUND STEEL DOWELS IN SLAB JOINTS SPACED AT 12" O/C. DOWELS SHALL BE SAWCUT TO LENGTH.
   B. DOWELS SHALL BE SECURELY SUPPORTED DURING CONCRETE PLACEMENT ON CONTINUOUS SLAB BOLSTERS ON EACH SIDE OF THE JOINT. POSITION AND ALIGN DOWELS TO BE PERPENDICULAR TO THE JOINT AND PARALLEL TO THE TOP SLAB SURFACE.
   C. AT CONSTRUCTION JOINT, GREASE END OF DOWEL PLACED IN FIRST SECTION OF CONCRETE. AFTER CONCRETE IN FIRST SECTION HAS HARDENED, MOVE DOWEL BACK AND FORTH IN HOLE TO INSURE THAT BOND IS BROKEN. AT DOWELED CONTROL JOINT, GREASE ENTIRE LENGTH OF DOWEL.
   D. DIAMOND PLATE JOINT KEYS MAY BE USED AS AN ALTERNATIVE TO DOWELS. SUBMIT PRODUCT DATA FOR APPROVAL.
3. SAWCUTTING:
   A. SAWCUT CONTROL JOINTS IMMEDIATELY AFTER COMPLETING SLAB SURFACE FINISHING AT EACH JOINT LOCATION AND AFTER THE CONCRETE IS SUFFICIENTLY SET TO LEAVE NO TRACKS ON THE SURFACE. SAW SHALL BE CAPABLE OF CUTTING OF HARDENED, UNCURED CONCRETE WITHOUT DAMAGING THE CONCRETE.
   B. SAW CUTS AT CONSTRUCTION JOINTS MAY BE MADE WHEN CONTROL JOINTS ARE CUT OR AT ANY TIME PRIOR TO THE TIME THAT JOINT SEALANTS OR FILLERS ARE TO BE INSTALLED.
   C. IMMEDIATELY AFTER SAWCUTTING, CLEAN THE JOINTS AND SLAB SURFACE. CLEANING SHALL REMOVE ALL LAITANCE, SAW DUST, AND OTHER CONTAMINANTS FROM SLAB SURFACE.
4. AFTER SAWING JOINTS AND CLEANING, COMMENCE CURING OF THE SLAB AND JOINTS AS SPECIFIED.

AT JOINTS NOTED ON PLANS AS DOWELED CONTROL JOINTS, THICKEN SLAB AND ADD DOWELS PER CONSTRUCTION JOINT DETAIL

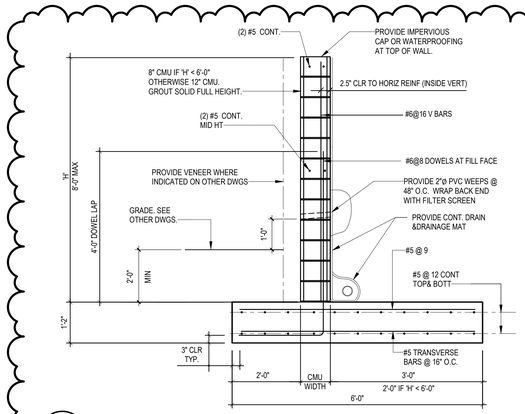
11 S-801 **SLAB-ON-GRADE JOINTS**
1" = 1'-0"



12 S-801 **SLAB-ON-GRADE REINFORCING**
1" = 1'-0"



13 S-801 **EDGE OF SLAB**
3/4" = 1'-0"



16 S-801 **TYPICAL DETAIL - SITE RETAINING WALL**
1/2" = 1'-0"

SITE RETAINING WALL GENERAL NOTES:

1. FOOTING DESIGNED FOR ASSUMED BEARING CAPACITY OF 2500 PSF.
2. ALL CONCRETE FOR FOOTINGS SHALL BE PLACED ON THE SAME DAY THAT THEIR EXCAVATIONS ARE MADE TO THE FINAL GRADE.
3. THE TOP OF ALL EXTERIOR FOOTINGS SHALL BE PLACED A MINIMUM OF 2'-0" BELOW FINISH GRADE.
4. CONTRACTOR SHALL VERIFY THE SOIL BEARING CAPACITY BEFORE ANY FOOTINGS ARE CAST.
5. ALL CAST-IN-PLACE CONCRETE SHALL BE NORMAL WEIGHT AND HAVE A MINIMUM COMPRESSIVE STRENGTH AT 28 DAYS OF 4000 PSI. UNO. SEE GENERAL NOTES ON S-001 AND SPECIFICATIONS FOR OTHER REQUIREMENTS.
6. WALL SHALL CONSIST OF FULLY GROUTED CMU (f'm = 1500 psi MINIMUM) WITH GRADE 60 REINFORCEMENT.
7. RETAINING WALL DRAWINGS SHALL BE USED IN CONJUNCTION WITH THE CIVIL ENGINEERS DRAWINGS, AND THE CONTRACTOR SHALL BE RESPONSIBLE FOR SEEING THAT THE WORK OF ALL TRADES IS COORDINATED WITH THIS WORK.
8. WHERE CONFLICTS OCCUR BETWEEN NOTES AND DRAWINGS THE CONTRACTOR SHALL NOT PROCEED WITH THE AFFECTED WORK UNTIL A CLARIFICATION IS ISSUED BY THE ENGINEER.
9. RETAINING WALL WAS DESIGNED UNDER THE FOLLOWING SOIL PARAMETERS:
   EQUIVALENT FLUID PRESSURE ..... 40 PCF
   PASSIVE RESISTIVE PRESSURE ..... 360 PCF

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112 South Tryon Street, Suite 1300
Charlotte, North Carolina 28284
(t) 704/372-6665

KWK ARCHITECTS
103 West Lockwood, Suite 218
St. Louis, Missouri 63119
(t) 314/942-8810

STANLEY D. LINDSEY & ASSOCIATES ENGINEERING, PA
Civil Engineer
NC License # C-1863
1437 Harding Place, Suite 201
Charlotte, North Carolina 28204

SKA CONSULTING ENGINEERS, INC.
Structural Engineer
NC License # F-0508
4651 Charlotte Park Drive, Suite 150
Charlotte, North Carolina 28217

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(t) 704/376-7777

NORTH CAROLINA PROFESSIONAL SEAL 19707 ENGINEER TIMOTHY E. GSM

UNC CHARLOTTE
Charlotte, NC
RESIDENCE HALL
PHASE XVI

SCO ID: 18-18333-02A

TAG	DESCRIPTION	DATE
1	ADDENDUM 1	8/26/2019

Project: 18NCC016
Drawn By: LAM
Checked By: TD
Date: 8/6/2019

TYPICAL DETAILS

PROJECT NORTH
TRUE NORTH

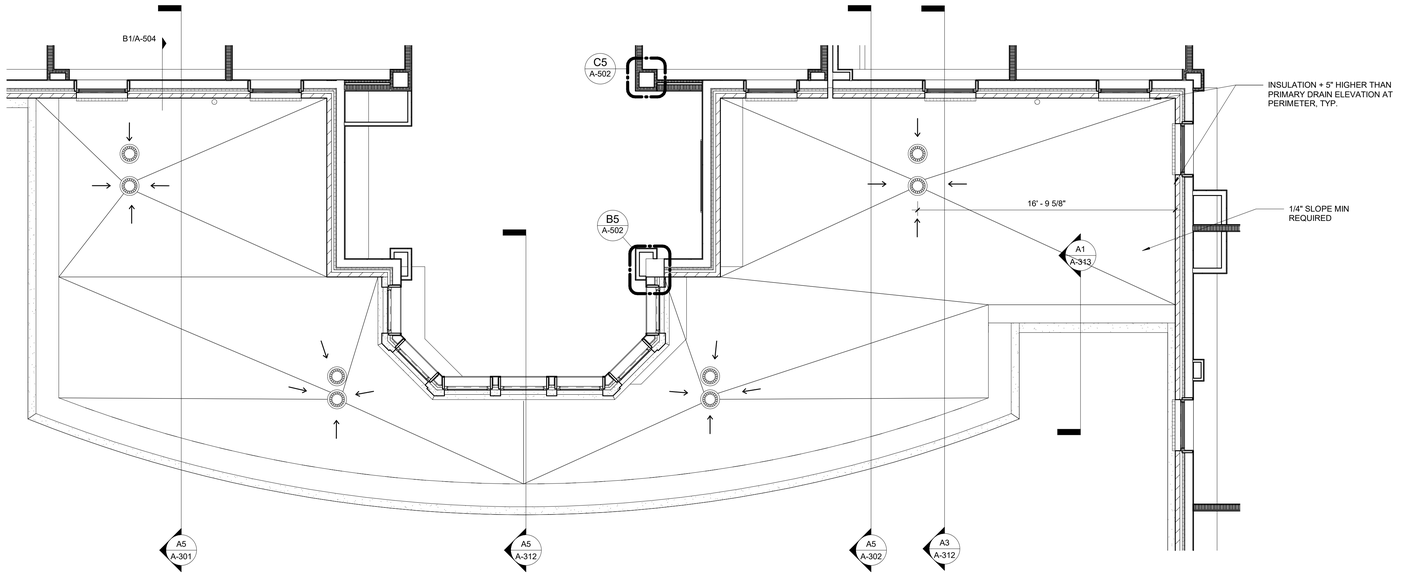
BID SET

S-801

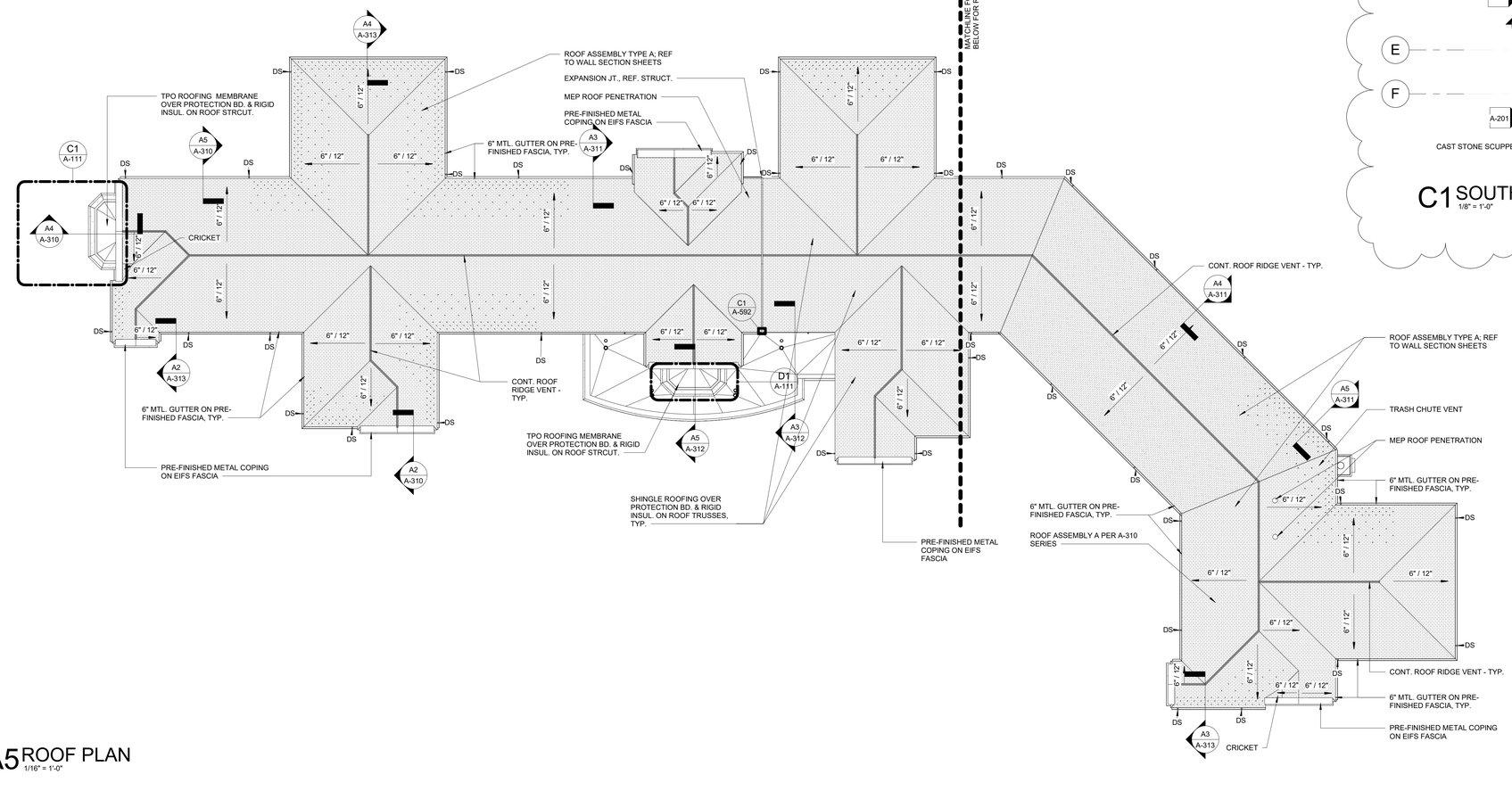
BIM 360://UNCC – Phase XVI/180008-RT17-S_UNCC PH 16.rvt

D C B A

5 4 3 2 1



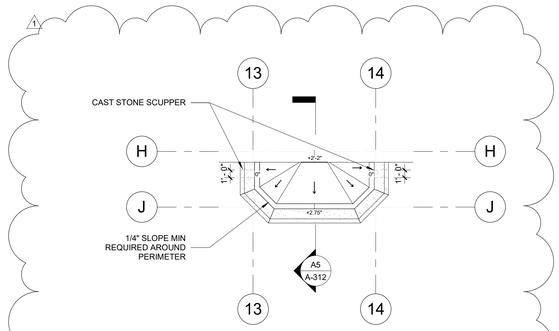
C5 LEVEL 2 - ROOF
1/4" = 1'-0"



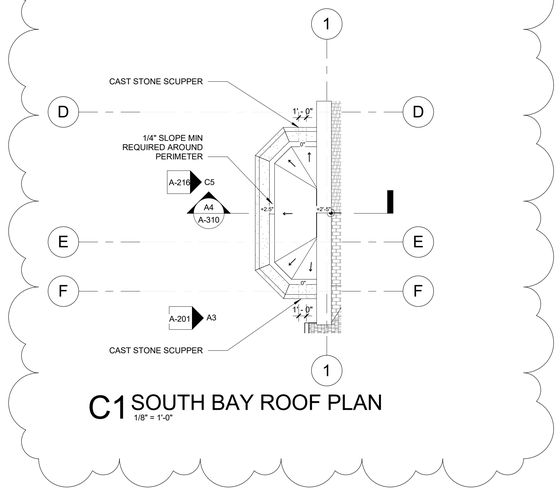
A5 ROOF PLAN
1/16" = 1'-0"

ROOF PLAN GENERAL NOTES

1. COORDINATE ALL ROOFTOP EQUIPMENT LOCATIONS AND PENETRATIONS WITH STRUCTURAL, MECHANICAL, PLUMBING, AND ELECTRICAL DRAWINGS.
2. PROVIDE SUMP SURROUNDS AT ALL ROOF DRAINS. SUMP SLOPE TO BE 1 1/2":12". SUMPS TO BE SQUARE WITH EACH SIDE AND DIMENSIONALLY EQUAL TO DRAIN BOWL DIAMETER PLUS 24". COORDINATE MOUNTING HEIGHT OF DRAIN BOWL FLANGE FOR SUMP SLOPE.
3. ROOF CURBS AT ALL MECHANICAL UNITS TO BE PRE-MANUFACTURED, INSULATED, AND SUPPLIED BY THE MECHANICAL CONTRACTOR.
4. SEE ELECTRICAL FOR LIGHTNING PROTECTION REQUIREMENTS
5. SEE SHEET A-521 FOR ADDITIONAL ROOF DETAILS



D1 WEST BAY ROOF PLAN
1/8" = 1'-0"



C1 SOUTH BAY ROOF PLAN
1/8" = 1'-0"

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Charlotte, North Carolina 28284
(t) 704/372-6665

KWK ARCHITECTS
103 West Lockwood, Suite 218
St. Louis, Missouri 63119
(t) 314/942-8810

STANLEY D. LINDSEY & ASSOC. ENGINEERING, PA
Civil Engineer
NC License # C-1863
1437 Harding Place, Suite 201
Charlotte, North Carolina 28204
(t) 704/333-3122

SKA CONSULTING ENG., PA
Structural Engineer
NC License # F-0508
4651 Charlotte Park Drive, Suite 150
Charlotte, North Carolina 28217
(t) 704/424-9663

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(t) 704/338-1292

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223 North Graham Street
Charlotte, NC 28202
(t) 704/376.7777

08/26/19

UNC CHARLOTTE
Charlotte, NC
RESIDENCE HALL PHASE XVI

SCO ID: 18-18333-02A

TAG	DESCRIPTION	DATE
1	Addendum 1	08/26/19

Project: 18NCC016
Drawn By: Designer
Checked By: Checker
Date: 08/26/19

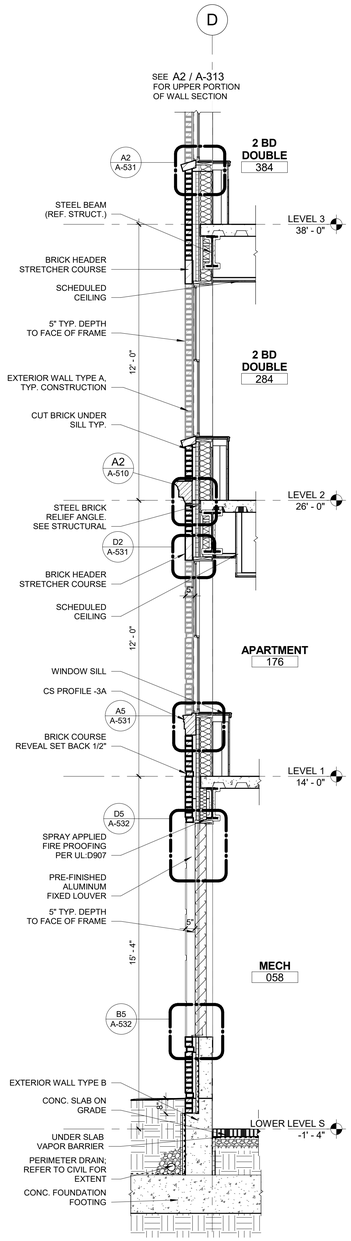
ROOF PLANS

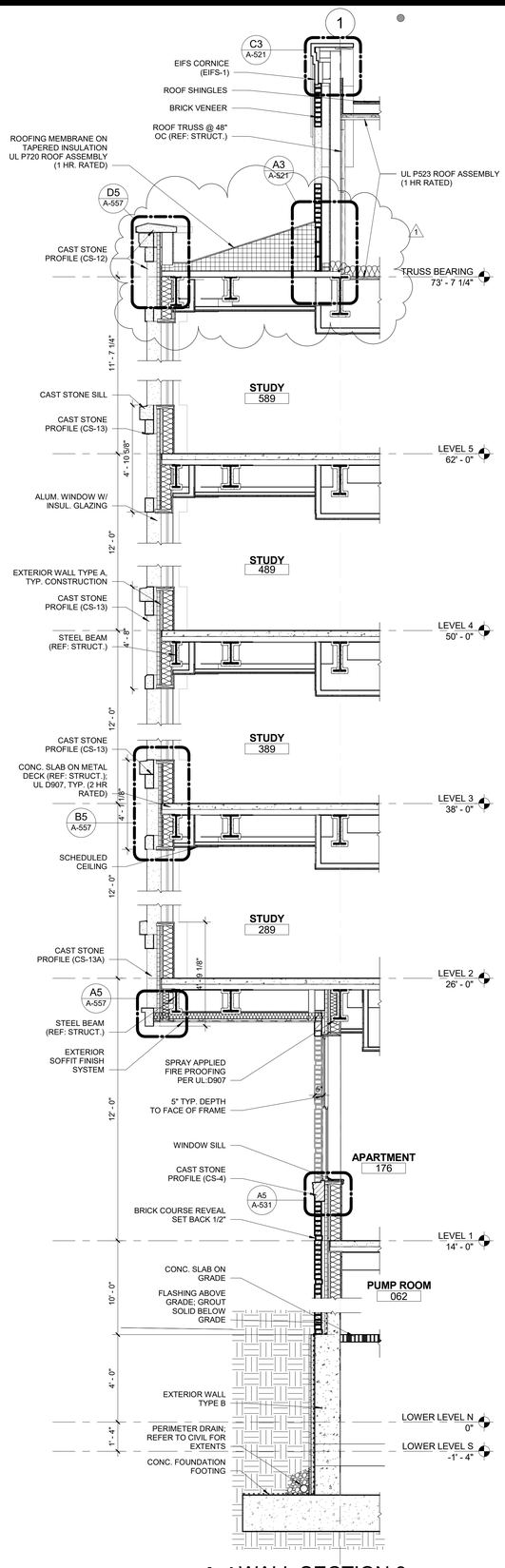
PROJECT NORTH
TRUE NORTH

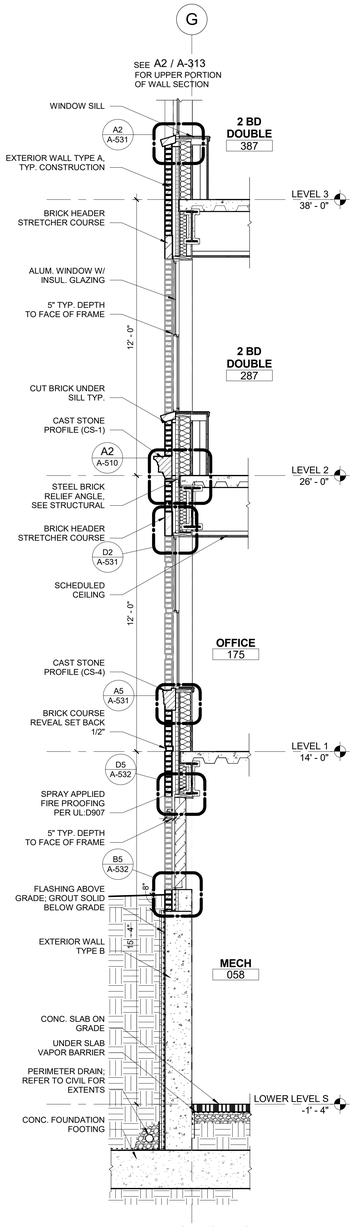
BID SET

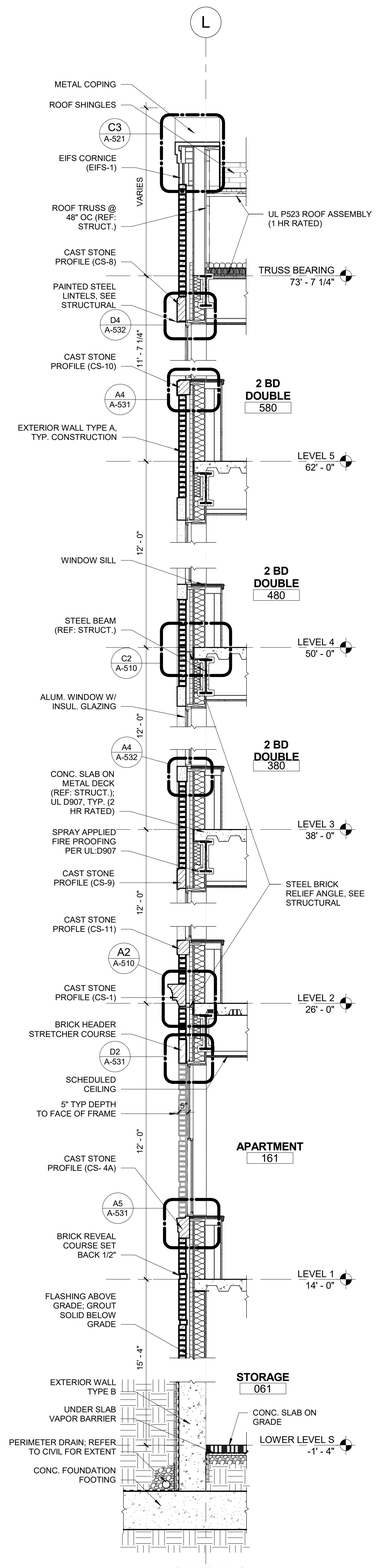
A-111

BIM 360://UNCC – Phase XVI/18010 UNCC-XVI A-V17.rvt









WALL SECTION NOTES

EXTERIOR ENVELOPE ASSEMBLY DESCRIPTIONS ARE TYPICAL CONDITIONS. SEE DRAWINGS FOR ATYPICAL CONDITIONS INCLUDING CAST STONE LOCATIONS, OUT-OF-PLANE BRICK COURSING, EXPANSION JOINTS, AND OTHER ELEMENTS. CONSTRUCT IN COMPLIANCE WITH THE REQUIREMENTS OF NFPA 285

EXTERIOR WALL TYPE A, 1'-2 1/4" THICK, TYPICAL:
1. EXTERIOR VENEER MASONRY
2. 2" CONTINUOUS AIR SPACE
3. 1-1/2" CONTINUOUS RIGID INSULATION (MIN R-7.5)
4. FLUID APPLIED AIR BARRIER ON 5/8" GLASS-MAT GYPSUM SHEATHING. SEAL ALL AIR BARRIER JOINTS, SEAMS, AND PENETRATIONS PER DETAILS AND MANUFACTURER INSTRUCTIONS.
5. 6" METAL STUDS @ 16" O.C., WITH BATT INSULATION BETWEEN STUDS (MIN R-13)
6. 5/8" TYPE X GYPSUM WALL BOARD
7. INTERIOR FINISHES AS SCHEDULED

EXTERIOR WALL TYPE A-1HR, 1'-2 1/4" THICK, TYPICAL. 1-HR NONBEARING WALL CONSTUCTION, PER NCBC TABLE 702.1(2), ITEM 15-2.3:
1. EXTERIOR VENEER MASONRY
2. 2" CONTINUOUS AIR SPACE
3. 1-1/2" CONTINUOUS RIGID INSULATION (MIN R-7.5)
4. FLUID APPLIED AIR BARRIER ON 5/8" GLASS-MAT GYPSUM SHEATHING. SEAL ALL AIR BARRIER JOINTS, SEAMS, AND PENETRATIONS PER DETAILS AND MANUFACTURER INSTRUCTIONS.
5. 6", 16 GA., MIN. METAL STUDS @ 16" O.C., WITH BATT INSULATION BETWEEN STUDS (MIN R-13)
6. 5/8" TYPE-X GYPSUM WALL BOARD, FASTED WITH 1" LONG NO. 6 DRYWALL SCREWS AT 12" O.C.
7. INTERIOR FINISHES AS SCHEDULED

EXTERIOR WALL TYPE B, BELOW GRADE:
1. BACKFILL PER CIVIL
2. FILTER FABRIC ON DRAINAGE BOARD
3. 1-1/2" CONTINUOUS PERIMETER RIGID INSULATION (MIN R-7.5)
4. BITUMINOUS WATERPROOFING
5. POURED-IN-PLACE CONCRETE, THICKNESS PER STRUCTURAL
6. INTERIOR FINISHES AS SCHEDULED

EXTERIOR SITE WALLS
1. REFER TO STRUCTURAL FOR STRUCTURAL REQUIREMENTS
2. REFER TO CIVIL FOR WALL HEIGHTS
3. REFER TO LANDSCAPING FOR WALL FINISHING DETAILS

ROOF TYPE A, STEEP-SLOPE. CONSTRUCT IN COMPLIANCE WITH THE REQUIREMENTS OF THE UL P523 1 HR RATED ASSEMBLY.
1. ASPHALT SHINGLES
2. ICE & WATER SHIELD, FULL COVERAGE. SEAL ALL JOINTS, SEAMS, AND PENETRATIONS PER DETAILS AND MANUFACTURER INSTRUCTIONS.
3. 3/4" PLYWOOD SHEATHING
4. STEEL DECKING PER STRUCTURAL
5. STEEL ROOF TRUSS PER STRUCTURAL

ROOF TYPE B, LOW-SLOPE. 1 HR RATED ASSEMBLY PER STRUCTURE
1. THERMOPLASTIC ROOFING (TPO)
2. POLYISO RIGID INSULATION SLOPED TO DRAIN, MIN. 5" THICK
3. 5/8" GYPSUM BOARD
4. COMPOSITE DECK PER STRUCTURAL

Jenkins • Peer *Architects*
112 South Tryon Street, Suite 1300
Charlotte, North Carolina 28284
(t) 704/372-6665

KWK ARCHITECTS
103 West Lockwood, Suite 218
St. Louis, Missouri 63119
(t) 314/942-8810

STANLEY D. LINDSEY & ASSOC. ENGINEERING, PA
Civil Engineer
NC License # C-1863
1437 Harding Place, Suite 201
Charlotte, North Carolina 28204
(t) 704/333-3122

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Structural Engineer
NC License # F-0508
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VICTOR A. JONES JR. — REGISTERED ARCHITECT — 4507 — NORTH CAROLINA — CHARLOTTE, NC

08/26/19

UNC CHARLOTTE
Charlotte, NC
RESIDENCE HALL PHASE XVI

SCO ID: 18-18333-02A

TAG	DESCRIPTION	DATE
1	Addendum 1	08/26/19

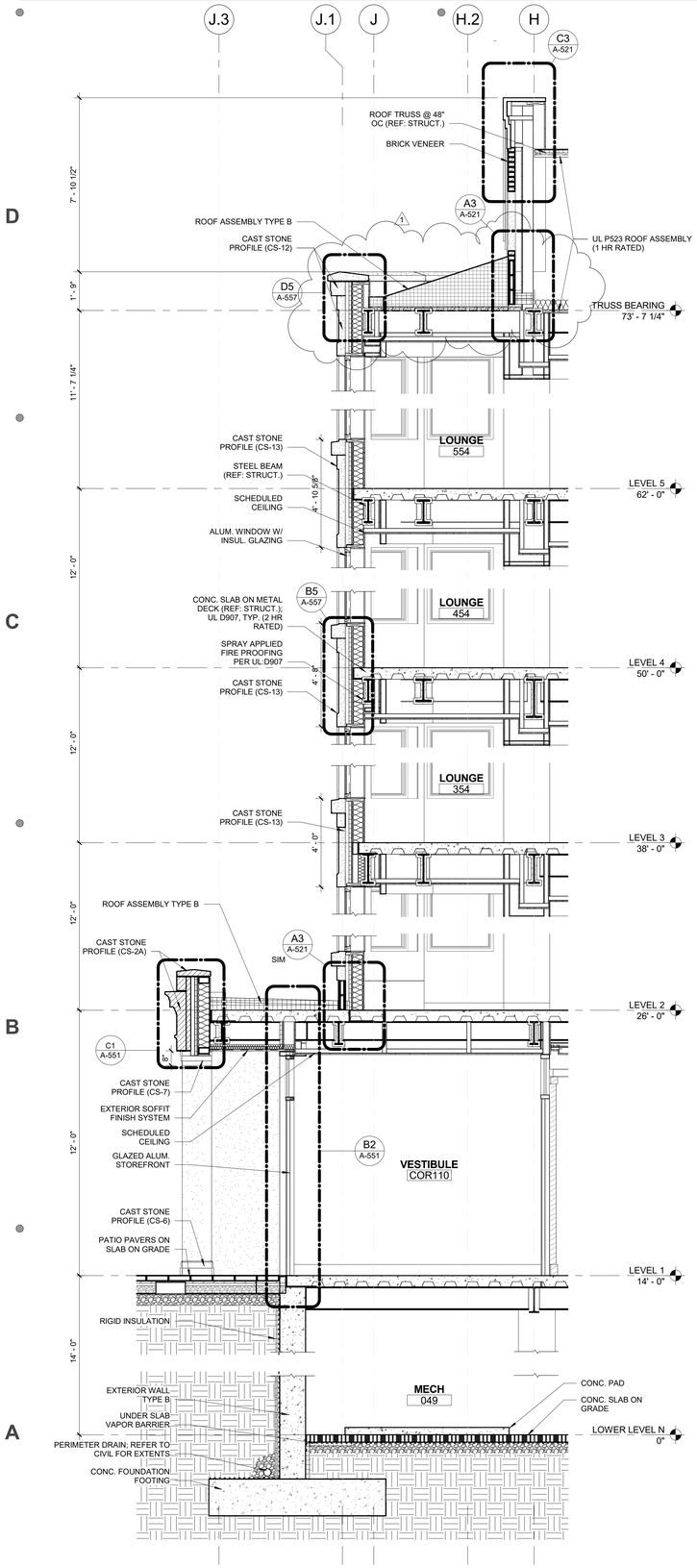
Project: 18NCC016
Drawn By: MH
Checked By: PP
Date: 08/26/19

WALL SECTIONS

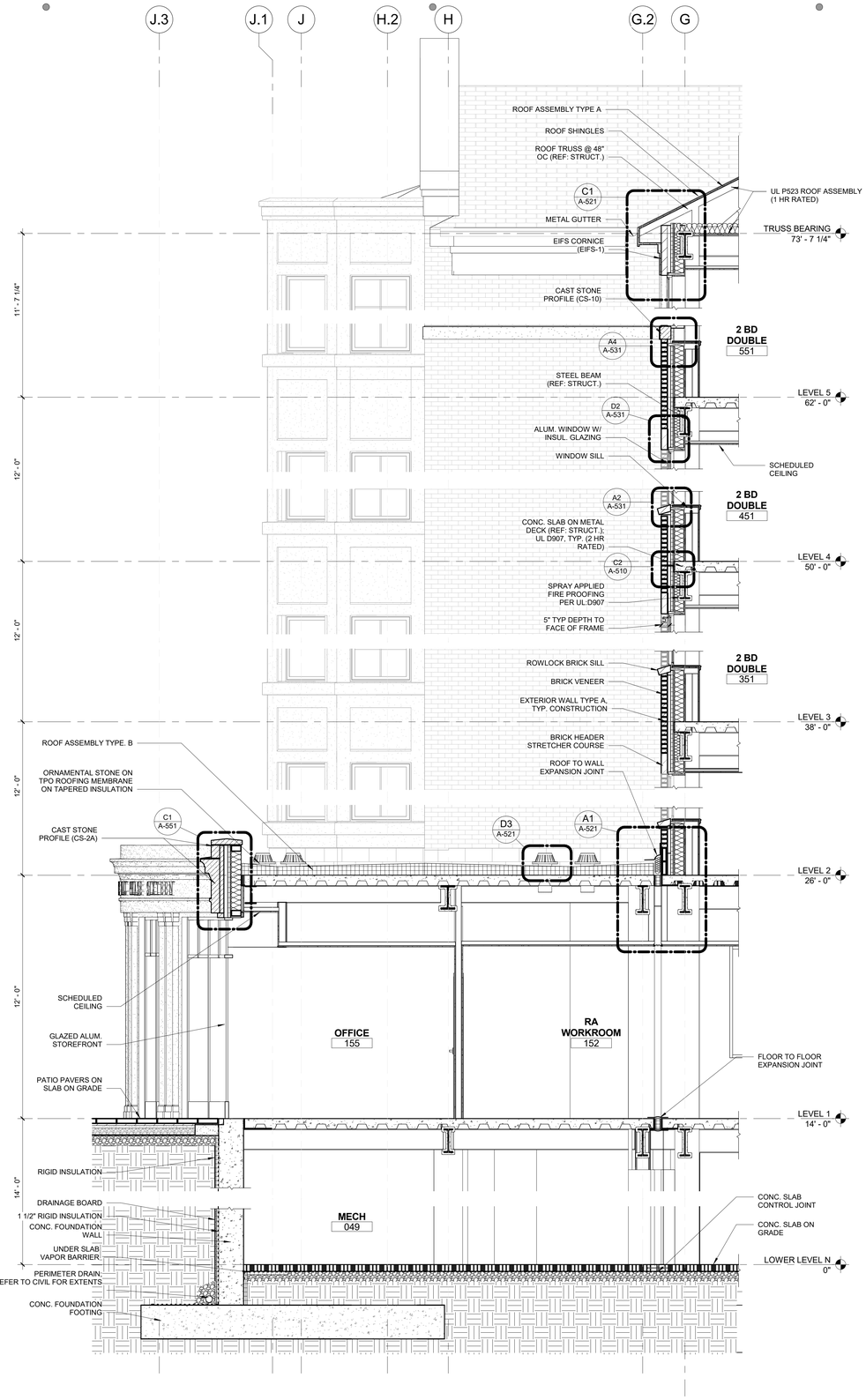
BID SET

A-310

BIM 360://UNCC – Phase XVI/18010 UNCC-XVI A-V17.rvt



A5 WALL SECTION 12
3/8" = 1'-0"



A3 WALL SECTION 11
3/8" = 1'-0"

WALL SECTION NOTES

EXTERIOR ENVELOPE ASSEMBLY DESCRIPTIONS ARE TYPICAL CONDITIONS. SEE DRAWINGS FOR ATYPICAL CONDITIONS INCLUDING CAST STONE LOCATIONS, OUT-OF-PLANE BRICK COURSING, EXPANSION JOINTS, AND OTHER ELEMENTS. CONSTRUCT IN COMPLIANCE WITH THE REQUIREMENTS OF NFPA 285

EXTERIOR WALL TYPE A, 1'-2 1/4" THICK, TYPICAL:
1. EXTERIOR VENEER MASONRY
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3. 1-1/2" CONTINUOUS RIGID INSULATION (MIN R-7.5)
4. FLUID APPLIED AIR BARRIER ON 5/8" GLASS-MAT GYPSUM SHEATHING. SEAL ALL AIR BARRIER JOINTS, SEAMS, AND PENETRATIONS PER DETAILS AND MANUFACTURER INSTRUCTIONS.
5. 6" METAL STUDS @ 16" O.C., WITH BATT INSULATION BETWEEN STUDS (MIN R-13)
6. 5/8" TYPE X GYPSUM WALL BOARD
7. INTERIOR FINISHES AS SCHEDULED

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3. 1-1/2" CONTINUOUS RIGID INSULATION (MIN R-7.5)
4. FLUID APPLIED AIR BARRIER ON 5/8" GLASS-MAT GYPSUM SHEATHING. SEAL ALL AIR BARRIER JOINTS, SEAMS, AND PENETRATIONS PER DETAILS AND MANUFACTURER INSTRUCTIONS
5. 6", 16 GA., MIN, METAL STUDS @ 16" O.C., WITH BATT INSULATION BETWEEN STUDS (MIN R-13)
6. 5/8" TYPE-X GYPSUM WALL BOARD, FASTED WITH 1" LONG NO. 6 DRYWALL SCREWS AT 12" O.C.
7. INTERIOR FINISHES AS SCHEDULED

EXTERIOR WALL TYPE B, BELOW GRADE:
1. BACKFILL PER CIVIL
2. FILTER FABRIC ON DRAINAGE BOARD
3. 1-1/2" CONTINUOUS PERIMETER RIGID INSULATION (MIN R-7.5)
4. BITUMINOUS WATERPROOFING
5. POURED-IN-PLACE CONCRETE, THICKNESS PER STRUCTURAL
6. INTERIOR FINISHES AS SCHEDULED

EXTERIOR SITE WALLS
1. REFER TO STRUCTURAL FOR STRUCTURAL REQUIREMENTS
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3. REFER TO LANDSCAPING FOR WALL FINISHING DETAILS

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3. 3/4" PLYWOOD SHEATHING
4. STEEL DECKING PER STRUCTURAL
5. STEEL ROOF TRUSS PER STRUCTURAL

ROOF TYPE B, LOW-SLOPE. 1 HR RATED ASSEMBLY PER STRUCTURE
1. THERMOPLASTIC ROOFING (TPO)
2. POLYISO RIGID INSULATION SLOPED TO DRAIN, MIN. 5" THICK
3. 5/8" GYPSUM BOARD
4. COMPOSITE DECK PER STRUCTURAL

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KWK ARCHITECTS
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St. Louis, Missouri 63119
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08/26/19

UNC CHARLOTTE
Charlotte, NC
RESIDENCE HALL PHASE XVI

SCO ID: 18-18333-02A

TAG	DESCRIPTION	DATE
1	Addendum 1	08/26/19

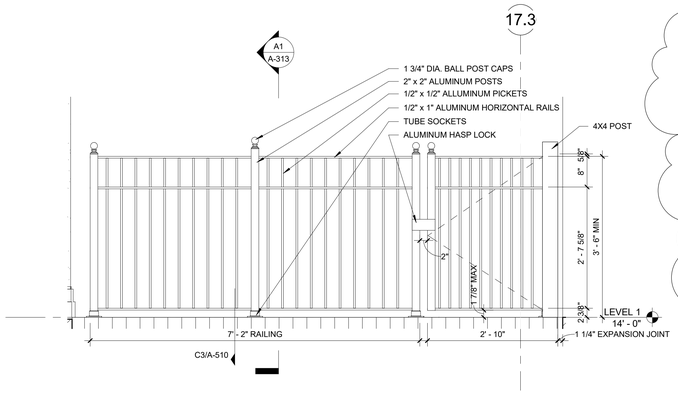
Project: 18NCC016
Drawn By: MH
Checked By: PP
Date: 08/26/19

WALL SECTIONS

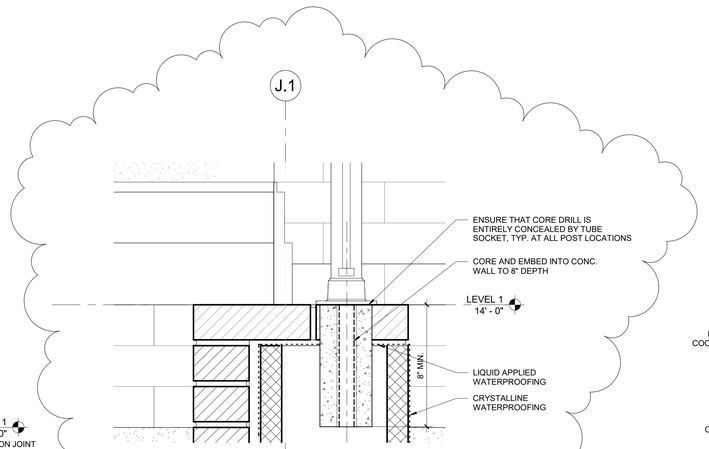
BID SET

A-312

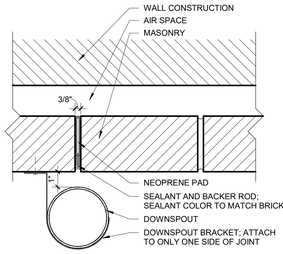
BIM 360://UNCC – Phase XVI/18010 UNCC-XVI A-V17.rvt



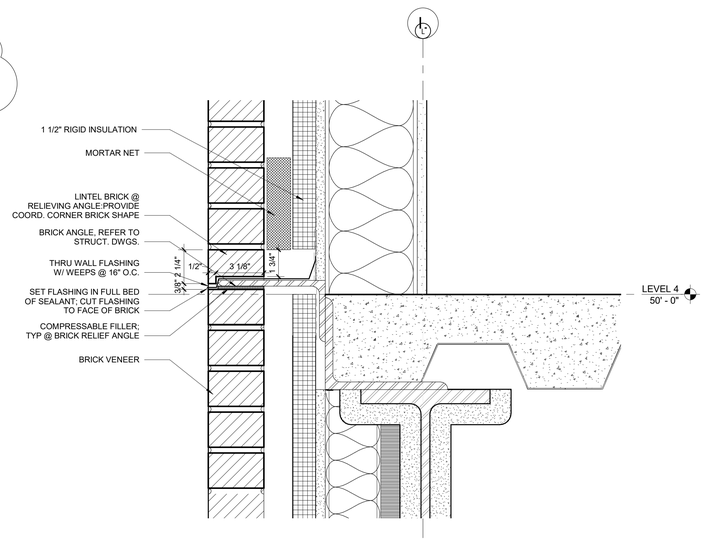
C5 AREAWAY RAILING
3/4" = 1'-0"



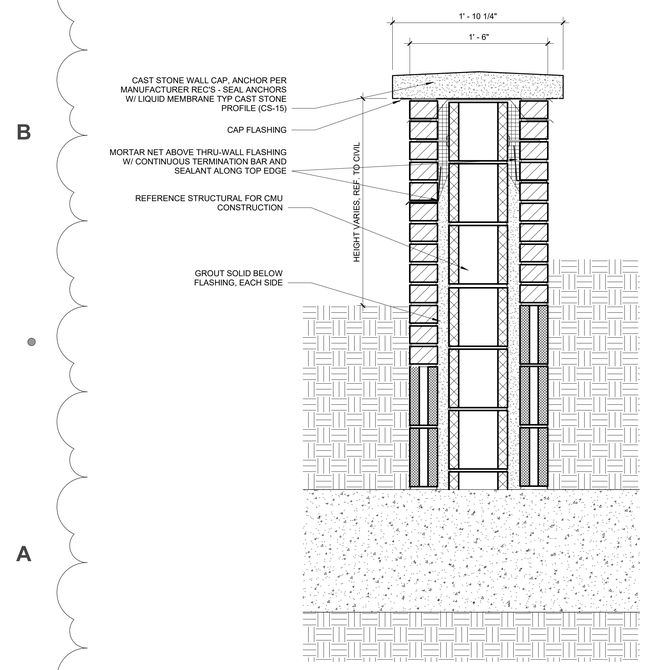
C3 RAILING ATTACHMENT DETAIL
3" = 1'-0"



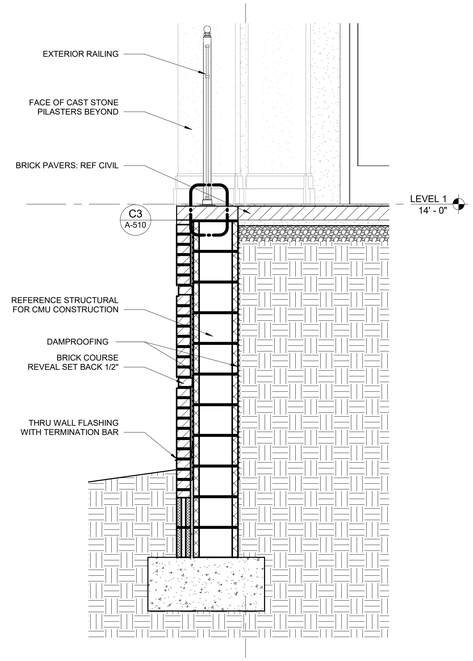
D1 TYP MASONRY EXPANSION JOINT
3" = 1'-0"



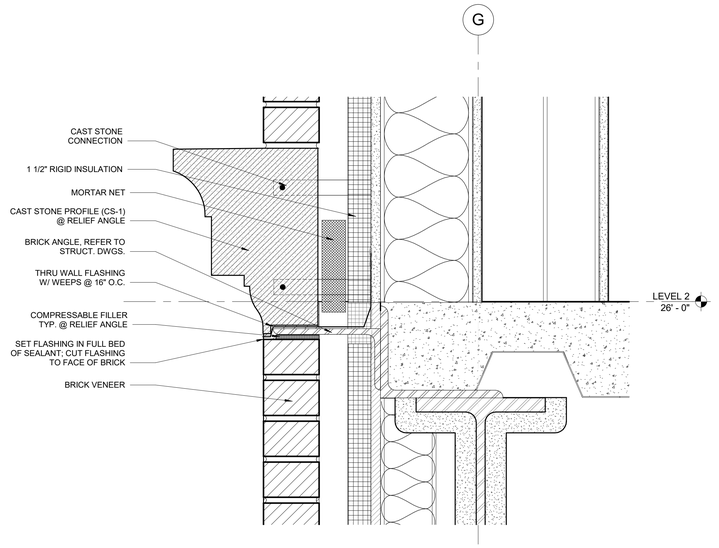
C2 BRICK ANGLE DETAIL @ LEVEL 4
3" = 1'-0"



A5 TYP. SITE WALL C.S. CAP -SECTION DTL
1 1/2" = 1'-0"



A3 SITE WALL SECTION
3/4" = 1'-0"



A2 BRICK ANGLE DETAIL @ LEVEL 2
3" = 1'-0"

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KWK ARCHITECTS
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St. Louis, Missouri 63119
(t) 314/942-8810

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08/26/19

UNC CHARLOTTE
Charlotte, NC
RESIDENCE HALL PHASE XVI

SCO ID: 18-18333-02A

TAG	DESCRIPTION	DATE
1	Addendum 1	08/26/19

Project: 18NCC016
Drawn By: MH
Checked By: PP
Date: 08/26/19

EXTERIOR DETAILS

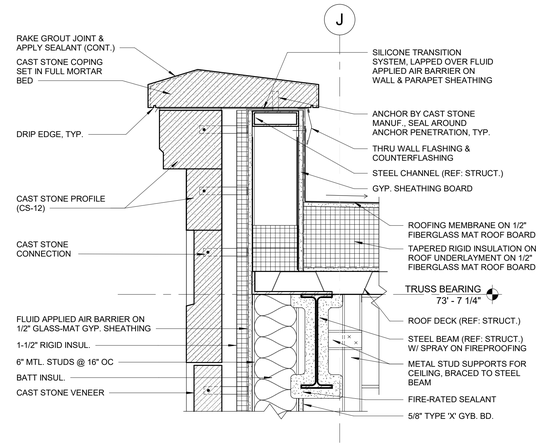
PROJECT NORTH
TRUE NORTH

BID SET

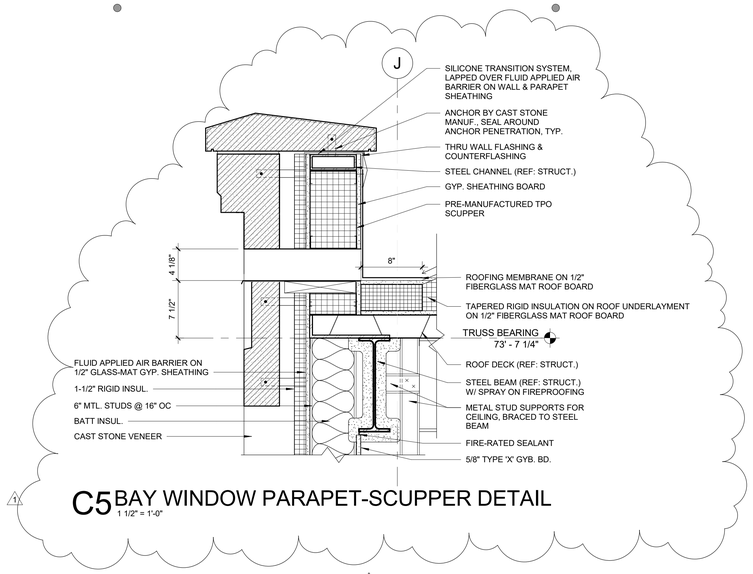
A-510

BIM 360://UNCC – Phase XVI/18010 UNCC-XVI A-V17.rvt

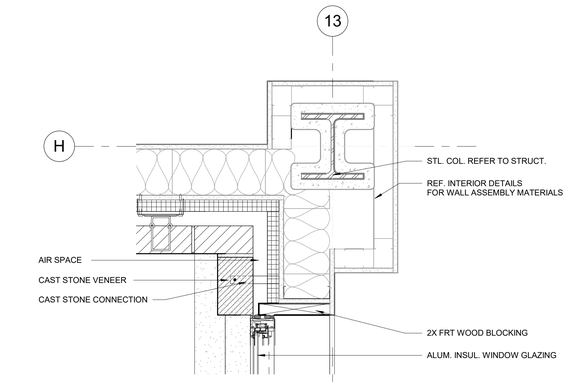
5 4 3 2 1
D C B A



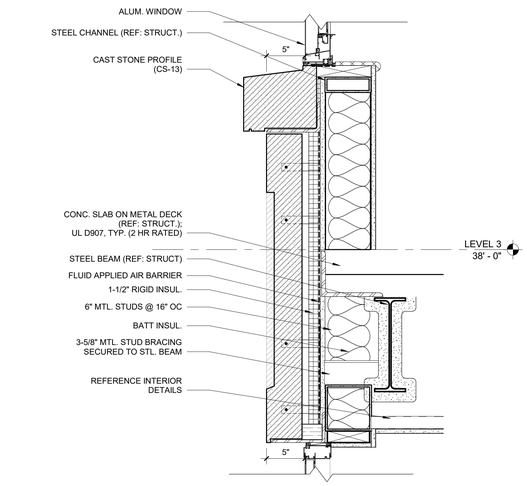
D5 BAY WINDOW PARAPET-CAST STONE DETAIL
1 1/2" = 1'-0"



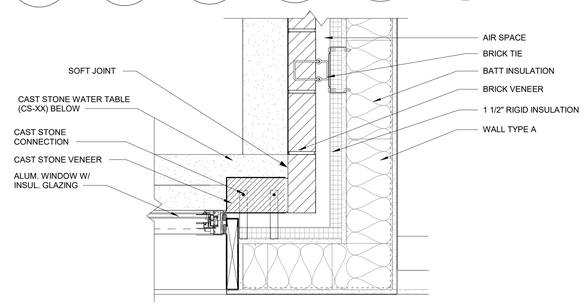
C5 BAY WINDOW PARAPET-SCUPPER DETAIL
1 1/2" = 1'-0"



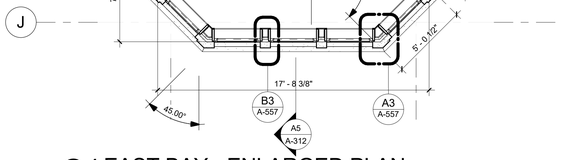
D3 EAST BAY CORNER DETAIL
1 1/2" = 1'-0"



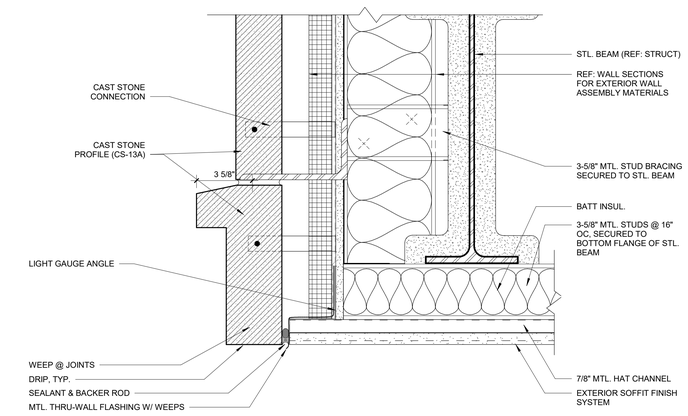
B5 BAY WINDOW-CAST STONE DETAIL
1 1/2" = 1'-0"



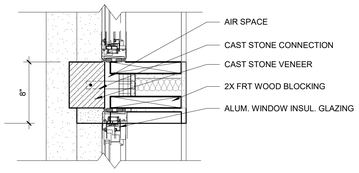
C3 SOUTH BAY CORNER DETAIL
1 1/2" = 1'-0"



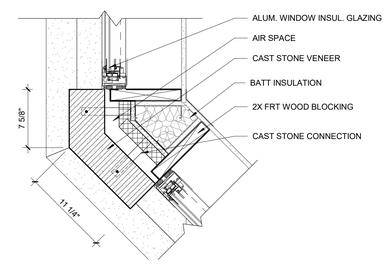
C1 EAST BAY - ENLARGED PLAN
1/4" = 1'-0"



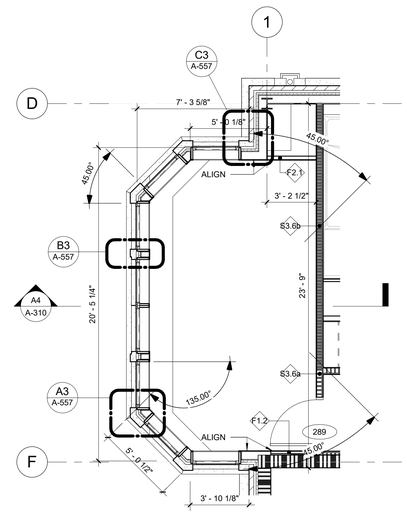
A5 SOUTH BAY SOFFIT-CAST STONE DETAIL
3" = 1'-0"



B3 BAY WINDOW DETAIL
1 1/2" = 1'-0"



A3 BAY WINDOW DETAIL
1 1/2" = 1'-0"



A1 SOUTH BAY - ENLARGED PLAN
1/4" = 1'-0"

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112 South Tryon Street, Suite 1300
Charlotte, North Carolina 28284
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KWK ARCHITECTS
103 West Lockwood, Suite 218
St. Louis, Missouri 63119
(t) 314/942-8810

STANLEY D. LINDSEY & ASSOC. ENGINEERING, PA
Civil Engineer
NC License # C-1863
1437 Harding Place, Suite 201
Charlotte, North Carolina 28204
(t) 704/333-3122

SKA CONSULTING ENG., PA
Structural Engineer
NC License # F-0508
4651 Charlotte Park Drive, Suite 150
Charlotte, North Carolina 28217
(t) 704/424-9663

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Charlotte, NC 28202
(t) 704/376.7777

08/26/19

UNC CHARLOTTE
Charlotte, NC
RESIDENCE HALL PHASE XVI

SCO ID: 18-18333-02A

TAG	DESCRIPTION	DATE
1	Addendum 1	08/26/19

Project: 18NCC016
Drawn By: MH
Checked By: PP
Date: 08/26/19

BAY DETAILS

PROJECT NORTH
TRUE NORTH

BID SET

A-557

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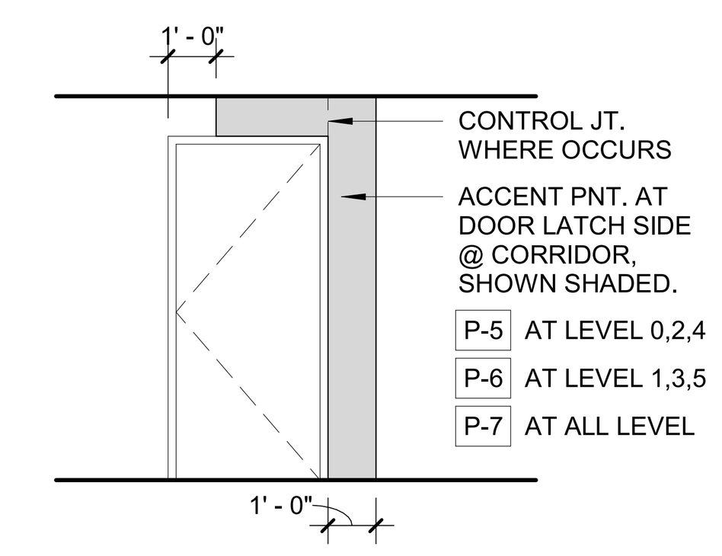
ACCENT PAINT @ TYP. UNIT DOOR



SPECIALTY FINISH LEGEND:

P-4	PAINT ACCENT
P-5	PAINT ACCENT LEVELS 0,2,4
P-6	PAINT ACCENT LEVELS 1,3,5
P-7	PAINT ACCENT
WG	STENCILED WALL GRAPHIC
MB	MARKERBOARD
T-4	3x9 HORIZONTAL WALL TILE
T-5	4x16 VERTICAL WALL TILE
T-6	HEX MOSAIC BACKSPLASH
TB	WALL TACKBOARD

A5 LOWER LEVEL SPECIALTY FINISH PLAN
1 : 135

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(t) 704/372-6665

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103 West Lockwood, Suite 218
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(t) 314/942-8810

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Civil Engineer
NC License # C-1863
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Structural Engineer
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Charlotte, North Carolina 28217
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Charlotte, NC
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SCO ID: 18-18333-02A

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Date: 08/26/19

LOWER LEVEL SPECIALTY FINISH PLAN

PROJECT NORTH
TRUE NORTH

BID SET

A-706

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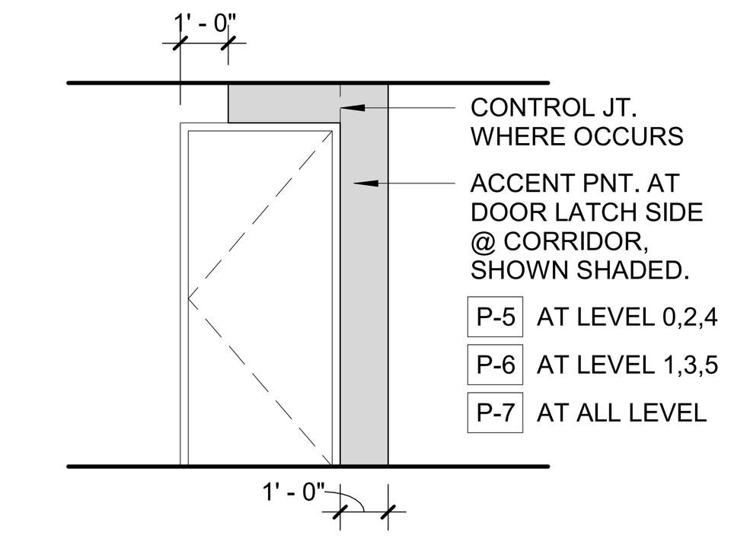
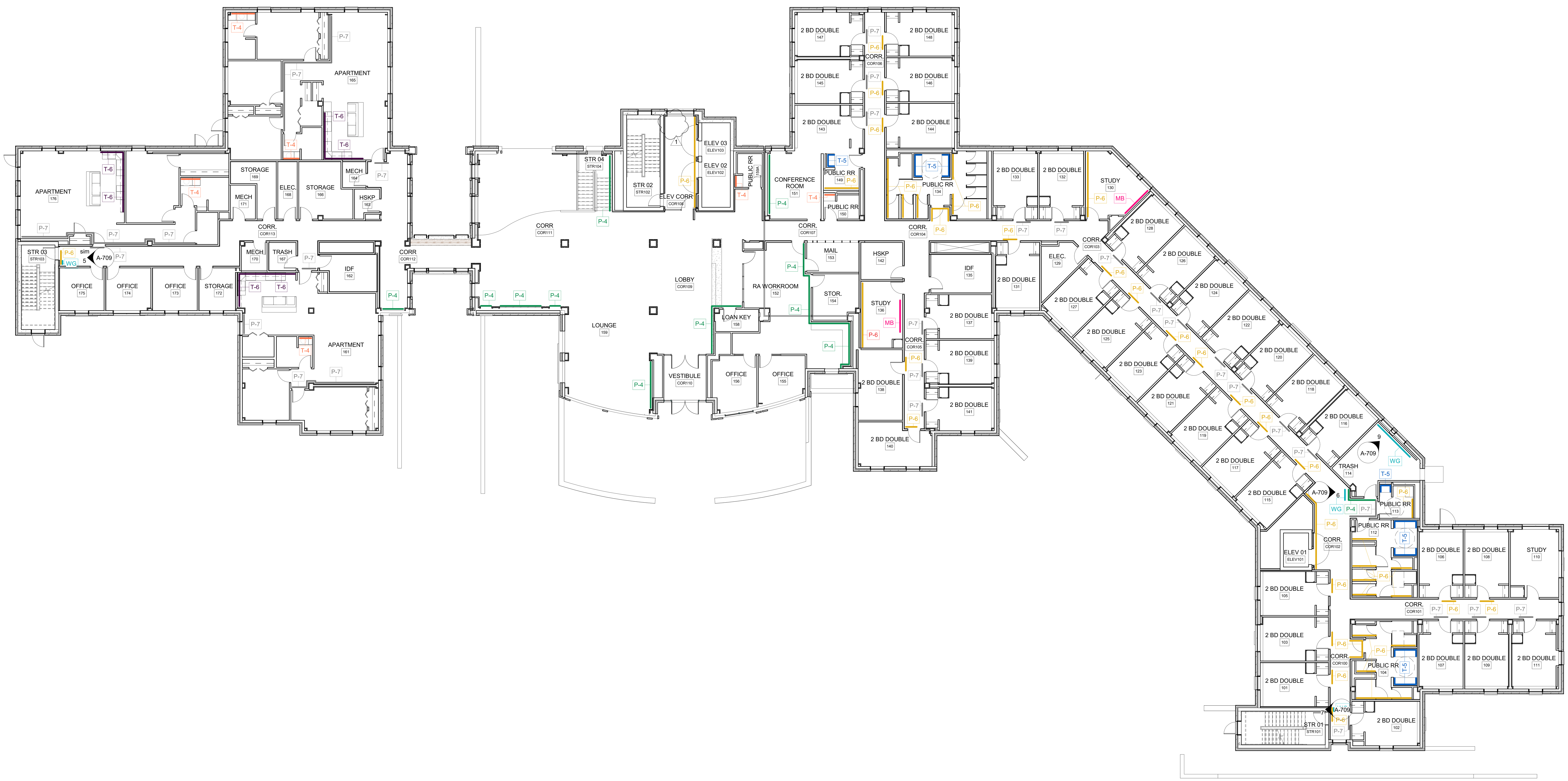
ACCENT PAINT @ TYP. UNIT DOOR



SPECIALTY FINISH LEGEND:

P-4	PAINT ACCENT
P-5	PAINT ACCENT LEVELS 0,2,4
P-6	PAINT ACCENT LEVELS 1,3,5
P-7	PAINT ACCENT
WG	STENCILED WALL GRAPHIC
MB	MARKERBOARD
T-4	3x9 HORIZONTAL WALL TILE
T-5	4x16 VERTICAL WALL TILE
T-6	HEX MOSAIC BACKSPLASH
TB	WALL TACKBOARD



A5 LEVEL 1 SPECIALTY FINISH PLAN

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112 South Tryon Street, Suite 1300
Charlotte, North Carolina 28284
(t) 704/372-6665

KWK ARCHITECTS
103 West Lockwood, Suite 218
St. Louis, Missouri 63119
(t) 314/942-8810

STANLEY D. LINDSEY & ASSOC. ENGINEERING, PA
Civil Engineer
NC License # C-1863
1437 Harding Place, Suite 201
Charlotte, North Carolina 28204
(t) 704/333-3122

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Structural Engineer
NC License # F-0508
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Charlotte, North Carolina 28217
(t) 704/424-9663

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NC License # C-0914
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(t) 704/338-1292

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UNC CHARLOTTE

Charlotte, NC

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LEVEL 1 SPECIALTY FINISH PLAN

PROJECT NORTH
TRUE NORTH

BID SET

A-707

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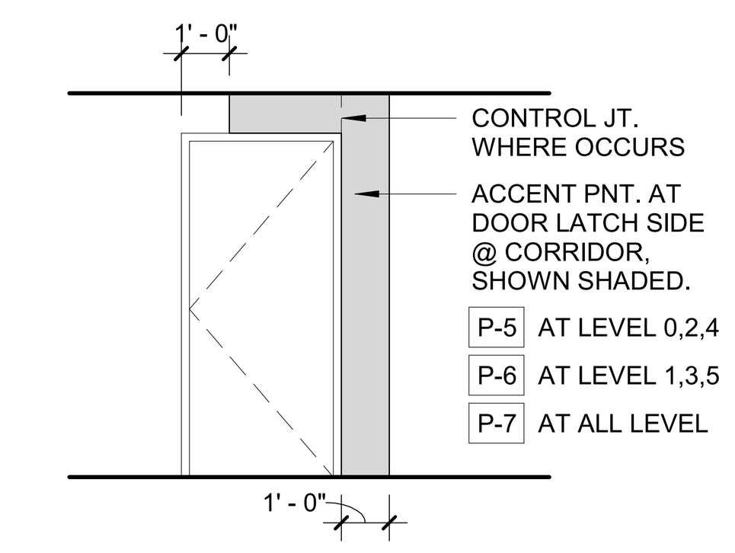
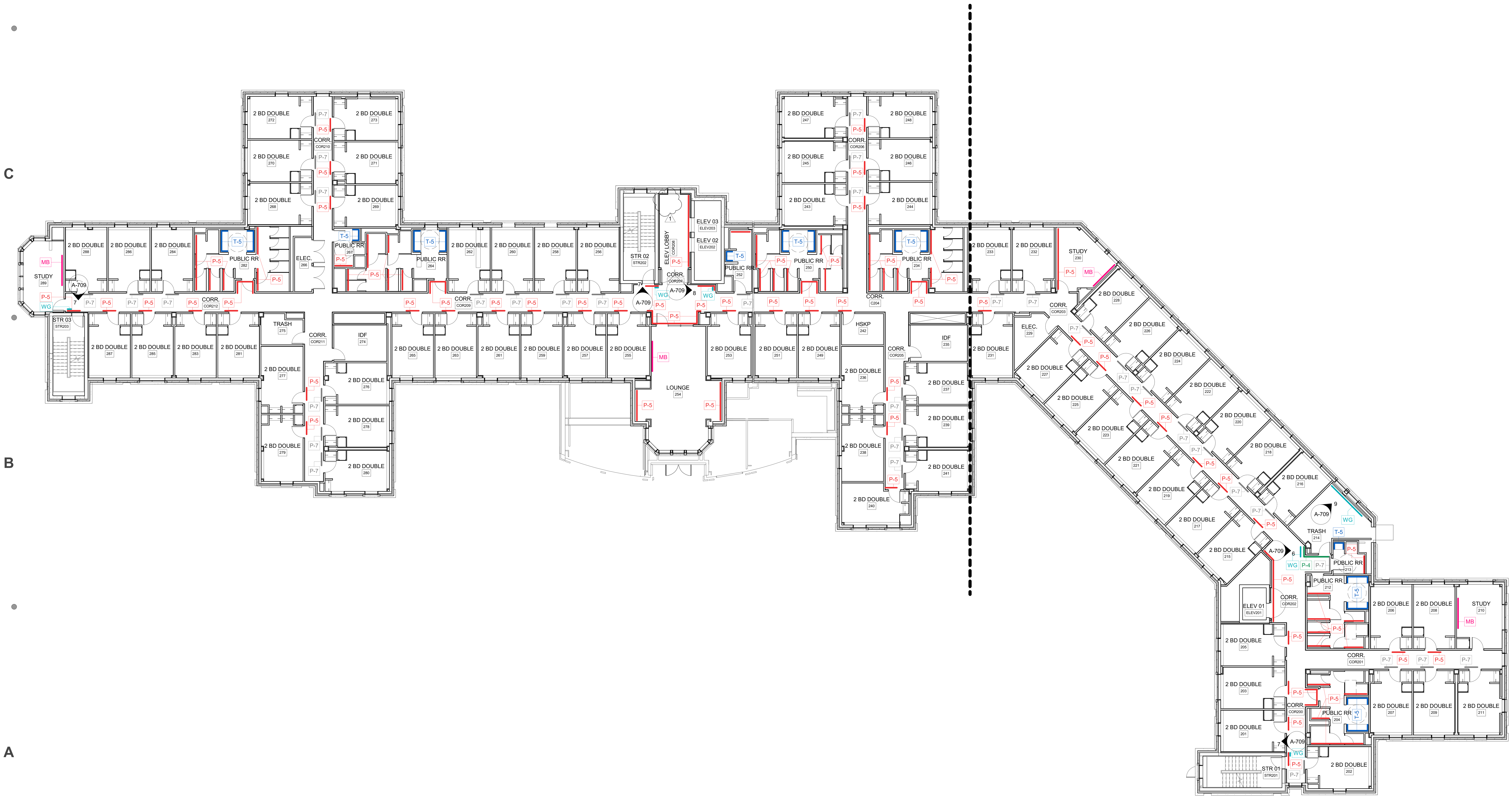
ACCENT PAINT @ TYP. UNIT DOOR



SPECIALTY FINISH LEGEND:

P-4	PAINT ACCENT
P-5	PAINT ACCENT LEVELS 0,2,4
P-6	PAINT ACCENT LEVELS 1,3,5
P-7	PAINT ACCENT
WG	STENCILED WALL GRAPHIC
MB	MARKERBOARD
T-4	3x9 HORIZONTAL WALL TILE
T-5	4x16 VERTICAL WALL TILE
T-6	HEX MOSAIC BACKSPLASH
TB	WALL TACKBOARD



A5 LEVEL 2-5 SPECIALTY FINISH PLAN

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Charlotte, North Carolina 28284
(t) 704/372-6665

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103 West Lockwood, Suite 218
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Civil Engineer
NC License # C-1863
1437 Harding Place, Suite 201
Charlotte, North Carolina 28204
(t) 704/333-3122

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4651 Charlotte Park Drive, Suite 150
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UNC CHARLOTTE

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SCO ID: 18-18333-02A

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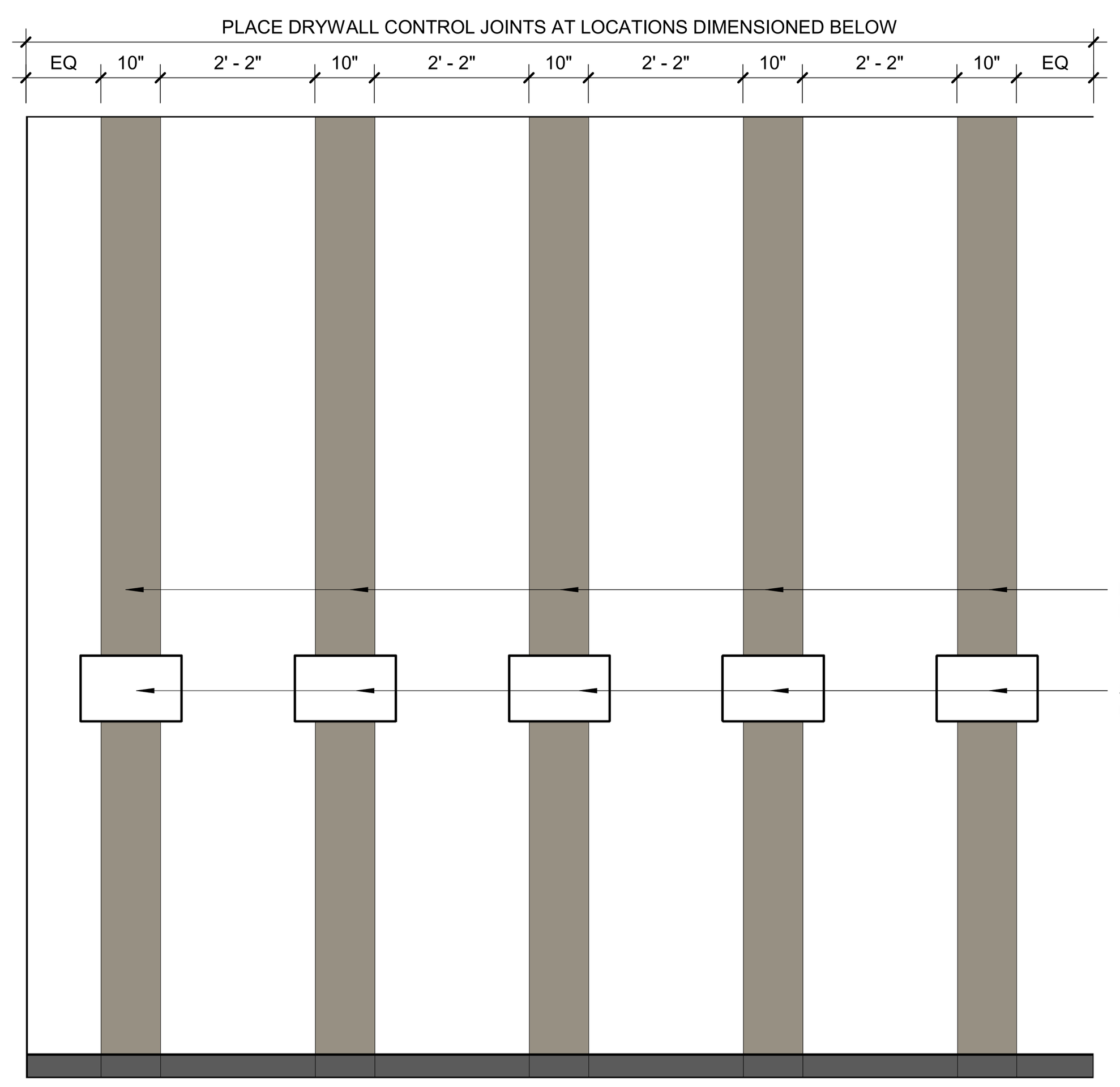
Checked By: Checker
Date: 08/26/19

LEVEL 2 SPECIALTY FINISH PLAN (LEVEL 3 TO 5 SIM.)

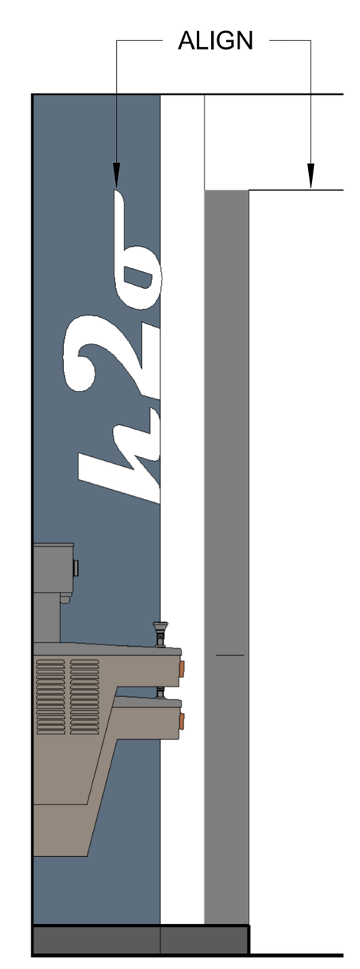
PROJECT NORTH
TRUE NORTH

BID SET

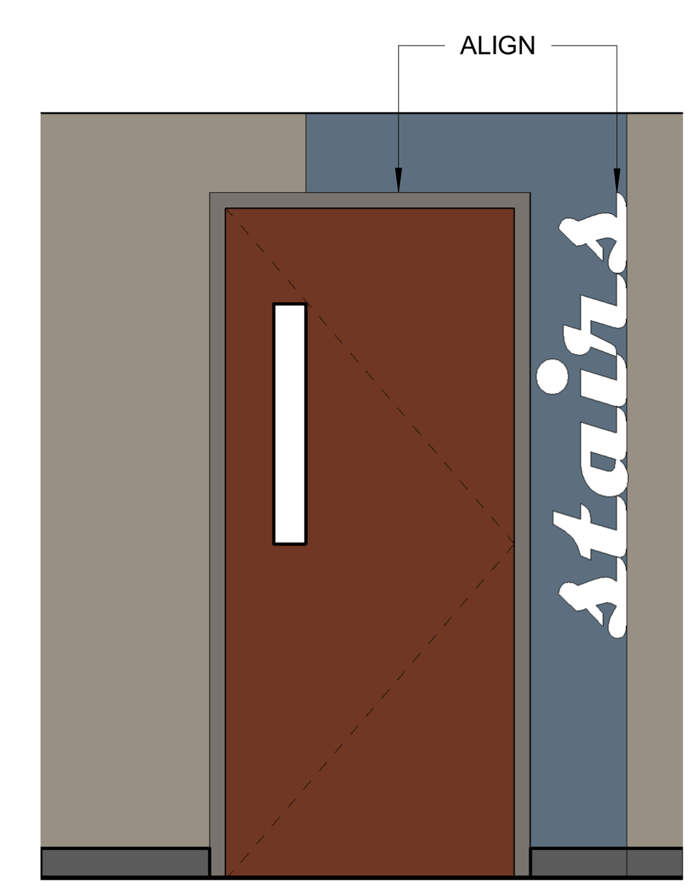
A-708



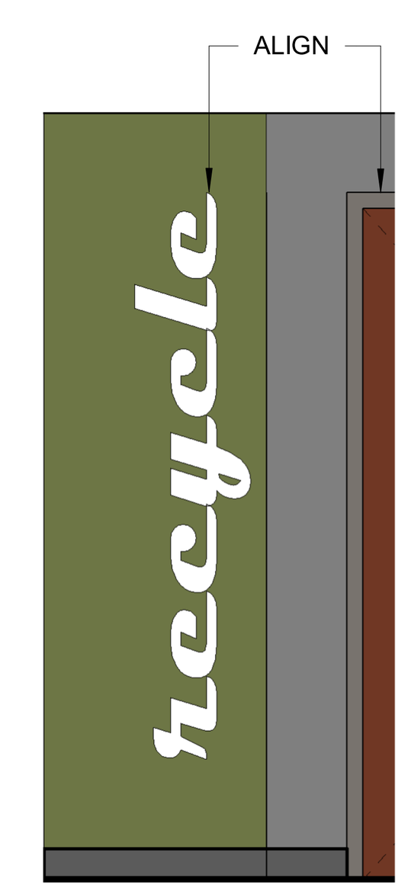
9 RECYCLING ROOM WALL GRAPHICS
1/2" = 1'-0"



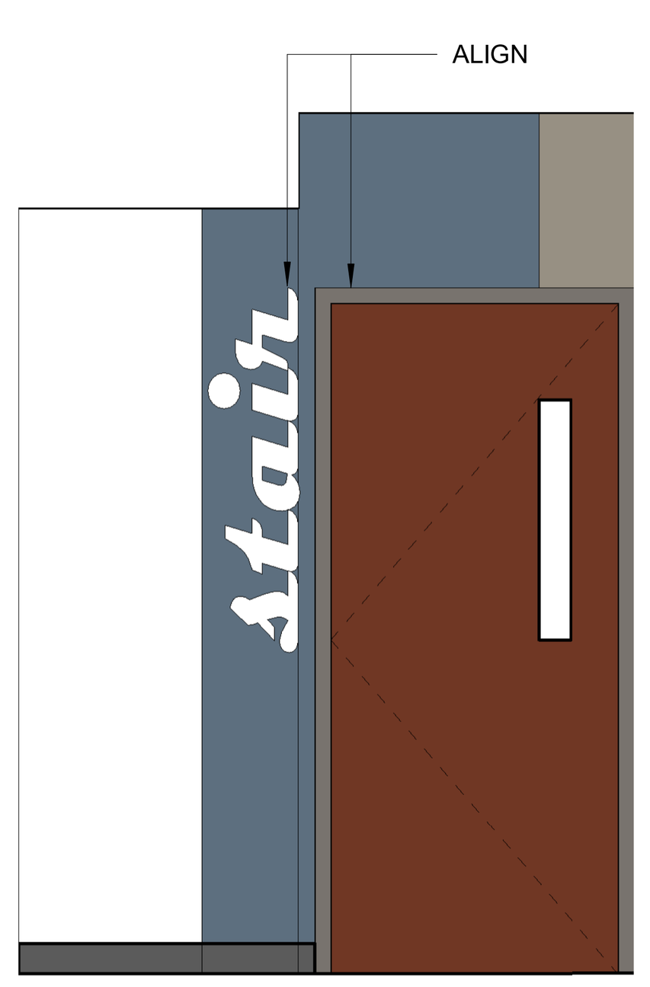
8 DRINKING FOUNTAIN WALL GRAPHIC
1/2" = 1'-0"



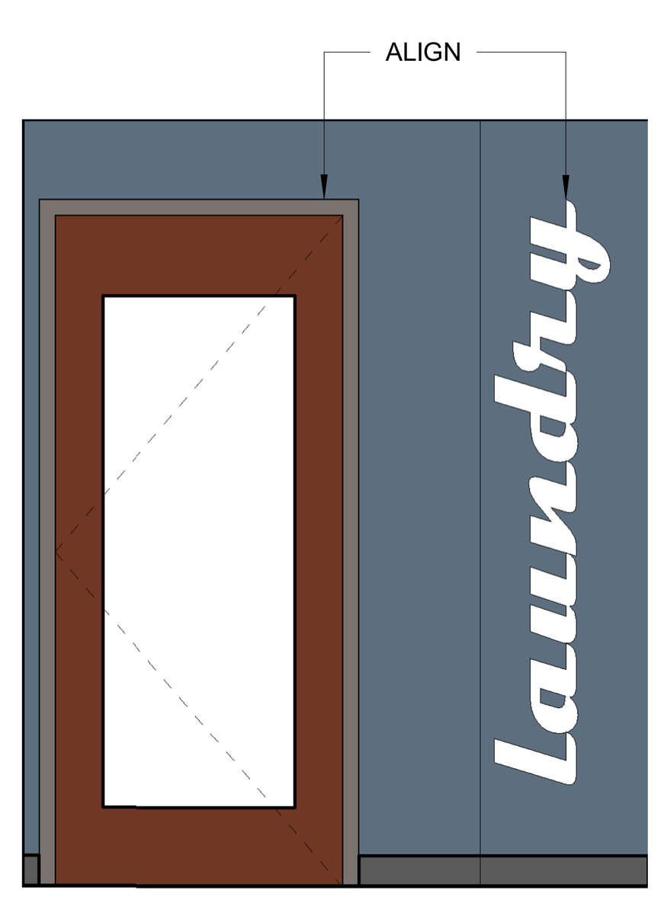
7 STAIR WALL GRAPHIC
1/2" = 1'-0"



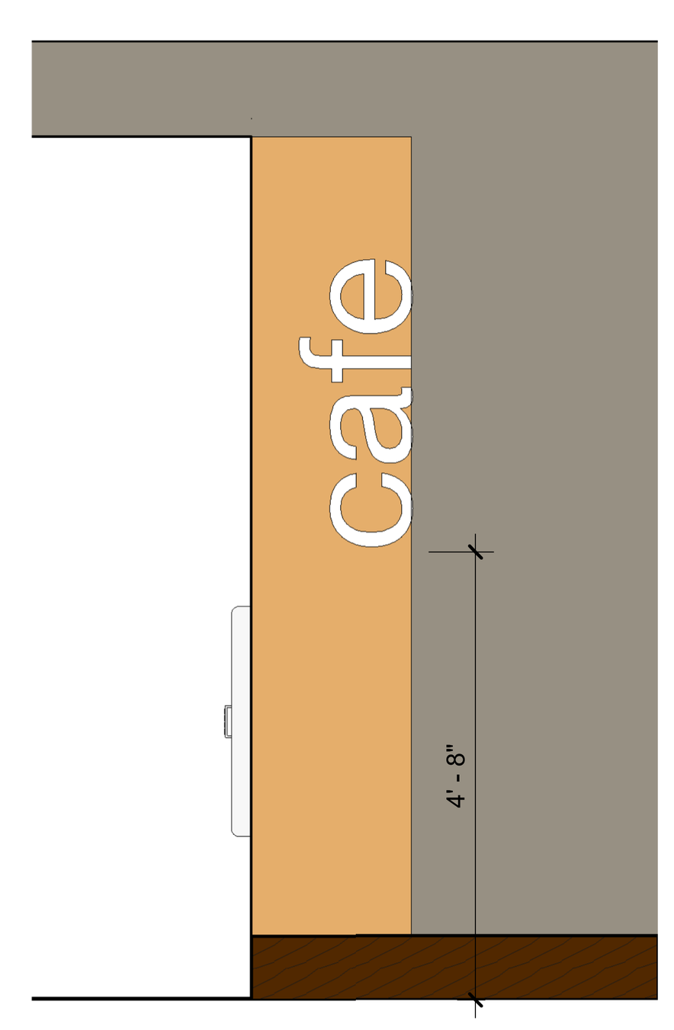
6 RECYCLING WALL GRAPHIC
1/2" = 1'-0"



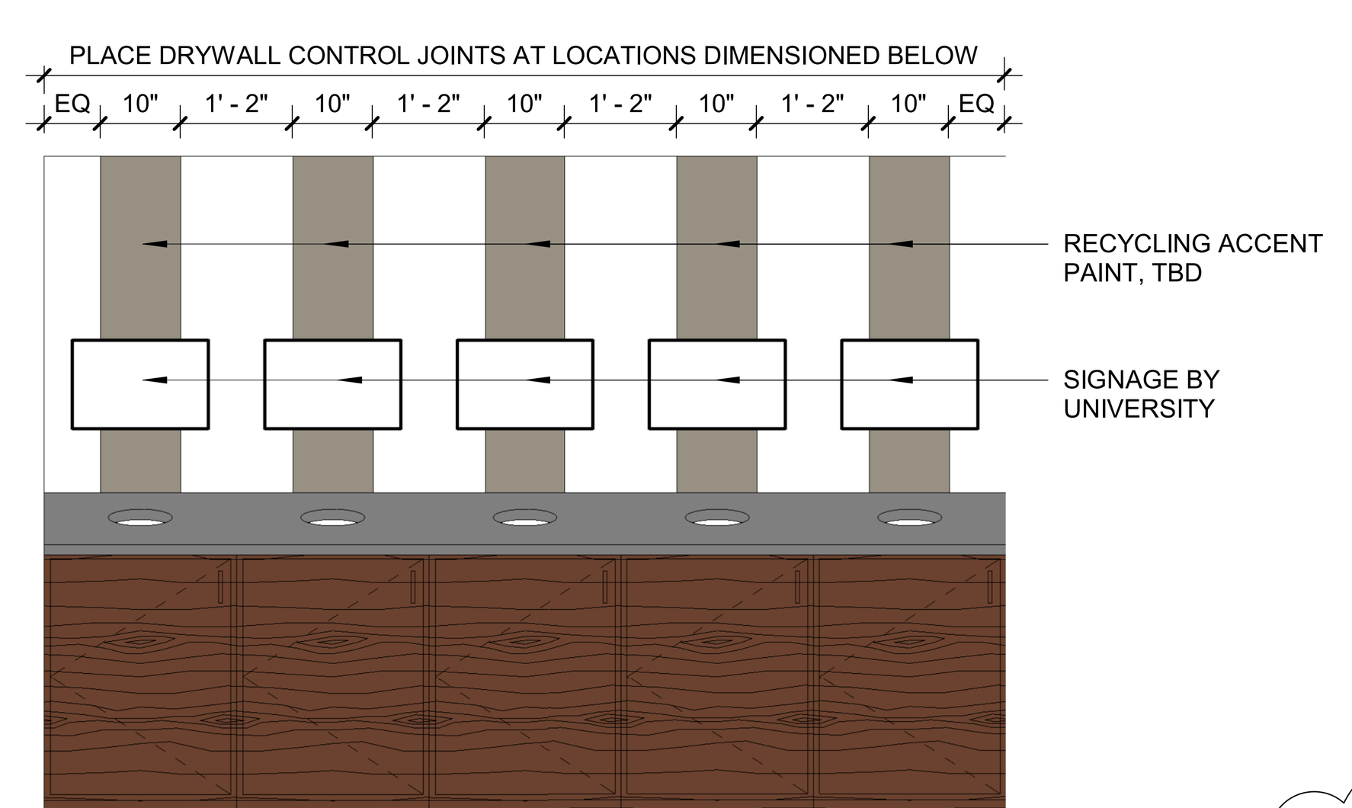
5 STAIR WALL GRAPHIC
1/2" = 1'-0"



4 LAUNDRY WALL GRAPHIC
1/2" = 1'-0"



3 CAFE WALL GRAPHIC
1/2" = 1'-0"



2 RECYCLING STATION WALL GRAPHICS
1/2" = 1'-0"

1
1/4" = 1'-0"

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103 West Lockwood, Suite 218
St. Louis, Missouri 63119
(t) 314/942-8810

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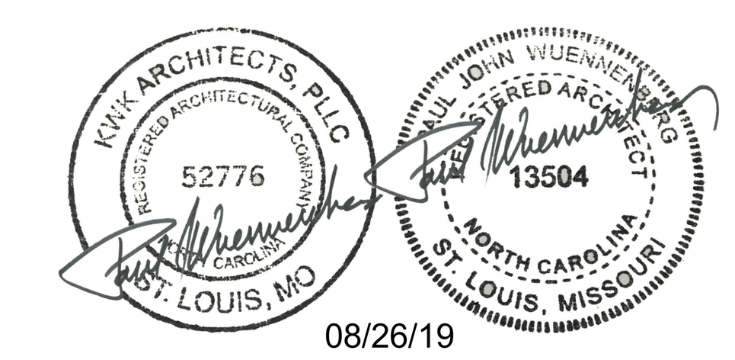

08/26/19

UNC CHARLOTTE
Charlotte, NC
RESIDENCE HALL PHASE XVI

SCO ID: 18-18333-02A

TAG	DESCRIPTION	DATE
1	Addendum 1	08/26/19

Project: 18NCC016
Drawn By: Designer
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SPECIALTY FINISH DETAILS

PROJECT NORTH
TRUE NORTH

BID SET

A-709

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2012 NORTH CAROLINA ENERGY CONSERVATION CODE

COMMERCIAL ENERGY EFFICIENCY - MECHANICAL SUMMARY

501.1 METHOD OF COMPLIANCE
☐ NC SPECIFIC COMCHECK PROVIDED
■ 2012 NCECC CHAPTER 5

501.2 APPLICATION COMPLIANCE
☐ 506.2.1 EFFICIENT MECH EQUIPMENT
☐ 506.2.2 REDUCED LTG DENSITY
■ 506.2.3 ENERGY RECOVERY SYSTEMS
☐ 506.2.4 HI EFFICIENCY DOMESTIC HW
☐ 506.2.5 ONSITE RENEWABLE ENERGY
☐ 506.2.6 DAYLIGHTING CONTROLS

301.1 CLIMATE ZONE 3A - MECKLENBURG COUNTY, NORTH CAROLINA

DESIGN CONDITIONS

EXTERIOR (ASHRAE 90.1-2007 TABLE D-1)
WINTER DRY BULB 18° F.
SUMMER DRY BULB 91° F.
SUMMER WET BULB 74° F.

INTERIOR (2012 NCECC SECTION 302.1)
WINTER DRY BULB 72° F.
SUMMER DRY BULB 75° F.
*PROVIDE 5°F DEADBAND PER 503.2.4.2

503.2 HEATING & COOLING LOADS AND EQUIPMENT & SYSTEM SIZING

BUILDING HEATING LOAD 5,400,000 BTUH (PEAK)
BUILDING COOLING LOAD 3,850,000 BTUH (PEAK)

INSTALLED HEATING CAPACITY ** BTUH
INSTALLED COOLING CAPACITY ** BTUH
**PROVIDED BY RUP-4

503.2.3 & 506.2.1 - REQUIRED & INCREASED HVAC EQUIPMENT PERFORMANCE
SYSTEM DESCRIPTION - 4 PIPE FAN COIL UNITS WITH ERV UNIT & CHW /HW FCU

■ MINIMUM HVAC EQUIPMENT EFFICIENCY COMPLIANCE - TABLE 503.2.3
☐ INCREASED HVAC EQUIPMENT EFFICIENCY COMPLIANCE - TABLE 506.2.1

EQUIP TYPE	SIZE CATEGORY (BTUH)	SUBCATEGORY	503.2.3 MINIMUM EFFICIENCY (b)	506.2.1 INCREASED EFFICIENCY	DESIGN EFFIC.
TABLE 5.3.2.3(1) - UNITARY AIR CONDITIONERS AND CONDENSING UNITS					
AIR COND, AIR COOLED	< 65,000 (<= 5 TONS)	SPLIT SYSTEM & SINGLE PACKAGE	13.0 SEER	15.0 SEER 12.5 EER	SEE SCHEDULE
AIR COND, AIR COOLED	>= 65,000 & < 135,000	SPLIT SYSTEM & SINGLE PACKAGE	11.2 EER (c)	12.0 EER 12.4 IPLV	SEE SCHEDULE
AIR COND, AIR COOLED	>= 135,000 & < 240,000	SPLIT SYSTEM & SINGLE PACKAGE	11.0 EER (c)	12.0 EER 12.4 IPLV	SEE SCHEDULE

b. IPLVS ARE ONLY APPLICABLE TO EQUIPMENT WITH CAPACITY MODULATION.
c. DEDUCT 0.2 FROM THE REQUIRED EERS AND IPLVS FOR UNITS WITH A HEATING SECTION OTHER THAN ELECTRIC RESISTANCE HEAT.

503.2.4 THRU 503.2.9

■ HVAC SYSTEMS ARE FULLY COMPLIANT WITH THE REQUIREMENTS FOR HVAC SYSTEM CONTROL, VENTILATION, ENERGY RECOVERY, DUCT AND PLENUM INSULATION AND SEALING, PIPING INSULATION, AND SYSTEM COMPLETION.

503.2.10 - AIR SYSTEM DESIGN AND CONTROL

☐ ALL FANS INSTALLED ON THE PROJECT ARE BELOW 5 HP AND ARE EXEMPT FROM THESE REQUIREMENTS.
■ FANS ABOVE 5 HP MEET THE CFM LIMITATIONS SHOWN BELOW:

OPTION 1 - FAN SYSTEM MOTOR NAMEPLATE HP - TABLE 503.2.10.1(1)

SYSTEM/UNIT	ALLOWABLE MOTOR BRAKE HP	DESIGN MOTOR BRAKE HP	DESIGN CFM
ERV-1 SUPPLY	REFER TO SCHEDULE	REFER TO SCHEDULE	SEE SCHEDULE
ERV-2 SUPPLY	REFER TO SCHEDULE	REFER TO SCHEDULE	SEE SCHEDULE
ERV-1 EXHAUST	REFER TO SCHEDULE	REFER TO SCHEDULE	SEE SCHEDULE
ERV-2 EXHAUST	REFER TO SCHEDULE	REFER TO SCHEDULE	SEE SCHEDULE

IF YOU DONT MEET THESE REQUIREMENTS, CHECK THE CODE AND USE OPTION 2

503.3 - SIMPLE HVAC SYSTEMS AND EQUIPMENT (PRESCRIPTIVE)

☐ PROJECT CONSISTS OF ONLY DX SINGLE ZONE SYSTEMS FULLY COMPLIANT WITH THE SIMPLE PRESCRIPTIVE REQUIREMENTS OF 503.3.

503.4 - COMPLEX HVAC SYSTEMS AND EQUIPMENT (PRESCRIPTIVE)

■ PROJECT CONSISTS OF HVAC SYSTEMS FULLY COMPLIANT WITH THE COMPLEX PRESCRIPTIVE REQUIREMENTS OF 503.4.

COORDINATION DRAWINGS

PER SPECIFICATION SECTION 01 31 00 PROJECT MANAGEMENT AND COORDINATION, THE CONSTRUCTION MANAGER (CM) SHALL ORGANIZE COORDINATION MEETINGS TO DEVELOP A SET OF COORDINATION DRAWINGS WITH ALL CONTRACTORS (ELECTRICAL, MECHANICAL, PLUMBING, FIRE PROTECTION, IT/DATA, AND GENERAL BUILDING TRADES). ANY RELOCATION OF SYSTEM ROUTINGS SHALL BE IDENTIFIED AND ADDRESSED IN THE COORDINATION PHASE BY EACH OF THE CONTRACTORS. THESE DRAWINGS, WHEN COMPLETED, SHALL BE SIGNED OFF BY ALL OF THE ABOVE LISTED PARTIES. COMPLETE COORDINATION DRAWINGS SHALL BE COMPLETED PRIOR TO FABRICATION AND INSTALLATION OF THE ASSOCIATED TRADES RESPECTIVE SYSTEMS, AND PURCHASE OF EQUIPMENT. THE FOLLOWING ITEMS REPRESENT THE MINIMUM REQUIREMENTS OF THE COORDINATION DRAWINGS:

1. ALL COORDINATION DRAWINGS WILL BE PRODUCED AT 1/4"= 1'-0" SCALE
2. COORDINATION DRAWINGS WILL BE DISTRIBUTED ON REPRODUCIBLE MATERIAL 30"x42"
4. COORDINATION DRAWINGS ARE NOT SHOP DRAWINGS AND ARE REQUIRED IN ADDITION TO SHOP DRAWINGS.
5. ONCE THE COMPLETE COORDINATION DRAWINGS HAVE BEEN COMPILED, THE (CM) WILL DISTRIBUTE ONE SIGNED SET TO EACH OF THE FOLLOWING CONTRACTORS MECHANICAL, ELECTRICAL, PLUMBING, FIRE PROTECTION, AND GENERAL TRADES. ADDITIONAL SETS WILL BE SENT TO THE OWNER, ARCHITECT, AND ENGINEER

THE USE OF BUILDING INFORMATION MODELING (BIM) THROUGHOUT THE CONSTRUCTION PROCESS IS A REQUIREMENT FOR THIS PROJECT TO HELP REDUCE OR ELIMINATE FIELD DETECTED CONFLICTS, IMPROVE CONSTRUCTION QUALITY AND MAINTAIN AN AGGRESSIVE SCHEDULE. THE (CM) WILL BE RESPONSIBLE FOR CREATING THE MODEL AND MANAGING THE COORDINATION AND COLLISION DETECTION PROCESS. THE MODEL MUST CONTAIN COMPLETE ARCHITECTURAL, STRUCTURAL, MECHANICAL, ELECTRICAL, PLUMBING AND FIRE PROTECTION SYSTEMS CONSISTENT WITH THE DESIGN AND FABRICATION DRAWINGS.

PIPING SYMBOLS

SYMBOL	DESCRIPTION
CHR	CHILLED WATER RETURN
CHS	CHILLED WATER SUPPLY
D	CONDENSATE DRAIN
HWR	HOT WATER RETURN
HWS	HOT WATER SUPPLY
G	NATURAL GAS
	BUTTERFLY VALVE
	3-PIECE BALL VALVE
	CHECK VALVE
	STRAINER WITH BLOWDOWN VALVE WITH HOSE CONN.
	BALANCING VALVE
	B&G CIRCUIT SETTER
	UNION
	THERMOMETER
P	PRESSURE GAGE & COCK
	GAGE COCK
	FLOW SWITCH
	ECCENTRIC REDUCER
	CONCENTRIC REDUCER
	CONTROL VALVE
	GAS COCK
	PRESSURE REDUCING/REGULATING VALVE
S	SOLENOID VALVE
T	THERMOSTAT / TEMP SENSOR (4'-0" AFF TO TOP)
H	HUMIDISTAT (4'-0" AFF TO TOP)
S	SWITCH (4'-0" AFF TO TOP)
DP	DIFFERENTIAL PRESSURE SENSOR
SP	DUCT-MOUNTED STATIC-PRESSURE SENSOR
CO	CARBON MONOXIDE SENSOR
CO2	DUCT MOUNTED CO2 SENSOR

HVAC SYMBOLS

SYMBOL	DESCRIPTION
16x8	SQUARE DUCT SIZE TAG (WIDTH x HEIGHT)
16/8	OVAL DUCT SIZE TAG (WIDTH / HEIGHT)
16"Ø	ROUND DUCT SIZE TAG (DIAMETER)
S/A	SUPPLY AIR
O/A	OUTDOOR AIR
R/A	RETURN AIR
E/A	EXHAUST AIR
FD	FIRE DAMPER W/ ACCESS DOOR (SEE DETAIL)
FSD	COMBINATION FIRE/SMOKE DAMPER W/ ACCESS DOOR (SEE DETAIL)
CD	CORRIDOR DAMPER W/ ACCESS DOOR (SEE DETAIL)
M	MOTORIZED DAMPER
B	BAROMETRIC DAMPER
DD	DUCT MOUNTED SMOKE DETECTOR W/ ACCESS DOOR
	SUPPLY AIR DIFFUSER (4-WAY)
	RETURN AIR GRILLE
	RETURN AIR GRILLE WITH SOUND BOOT
	EXHAUST AIR GRILLE
	AIRFLOW DIRECTION
M.C.	MECHANICAL CONTRACTOR
E.C.	ELECTRICAL CONTRACTOR
P.C.	PLUMBING CONTRACTOR
N.I.C.	NOT IN CONTRACT
(EX)	EXISTING
AFF	ABOVE FINISHED FLOOR
DN	DOWN
UP	UP
X / X	SECTION CUT REFERRING DETAIL NUMBER REFERRING SHEET NUMBER

BIM / ILM GENERAL NOTE

CM SHALL BE RESPONSIBLE FOR PROVIDING THE FINAL COORDINATION MODEL TO THE OWNER AT THE PROJECT COMPLETION THAT MEETS ALL APPLICABLE FORMATTING AND DOCUMENTATION REQUIREMENTS AS NOTED IN THE LATEST VERSION OF THE UNC CHARLOTTE BIM/VDC REQUIREMENTS IMPLEMENTATION PLAN. ITEMS THAT SHALL BE PROVIDED INCLUDE BUT IS NOT LIMITED TO: INPUT OF ASSOCIATED EQUIPMENT MODEL NUMBERS, SERIAL NUMBERS, TRACKING DATA ASSET TAGS, O+M MANUALS, ETC. COMPLETED MODEL SHALL BE PROVIDED NO LATER THAN 30 DAYS AFTER SCO FINAL INSPECTION.

MECHANICAL GENERAL NOTES

1. DO NOT SCALE DRAWINGS. SEE ARCHITECTURAL DRAWINGS AND REFLECTED CEILING PLANS FOR EXACT LOCATION OF DOORS, WINDOWS, CEILING DIFFUSERS, ETC.
2. ALL COST ASSOCIATED WITH SUBSTITUTED EQUIPMENT TO COMPLY WITH BASIS OF DESIGN, INCLUDING PROVIDING MAINTENANCE ACCESS, CLEARANCE, PIPING, SHEET METAL, ELECTRICAL, REPLACEMENT OF OTHER SYSTEM COMPONENTS, BUILDING ALTERATIONS, ETC., SHALL BE INCLUDED IN THE ORIGINAL BASE BID. NO ADDITIONAL COST ASSOCIATED WITH SUBSTITUTED EQUIPMENT WILL BE APPROVED DURING CONSTRUCTION AND ALL COST WILL BE THE RESPONSIBILITY OF THE MECHANICAL CONTRACTOR. THIS INCLUDES ANY MODIFICATIONS TO ANY ASSOCIATED MECHANICAL, PLUMBING, OR ELECTRICAL SYSTEMS REQUIRED BY THIS SPECIFIC MANUFACTURER'S INSTALLATION INSTRUCTIONS.
3. ALL DUCTWORK SHALL BE GALVANIZED SHEET METAL CONSTRUCTED IN ACCORDANCE WITH THE LATEST SMACNA STANDARDS. ALL SUPPLY, RETURN AND OUTSIDE AIR DUCTWORK SHALL BE WRAPPED WITH 2" THICK DUCT WRAP WITH VAPOR BARRIER. INSULATION (INCLUDING FLEXIBLE DUCT INSULATION) SHALL HAVE A MINIMUM INSTALLED R-VALUE OF 5.0. TRANSFER DUCTS SHALL BE LINED WITH 1" THICK CLOSED CELLULAR FOAM LINER FOR ACOUSTICAL PURPOSES. DUCT DIMENSIONS ON PLANS ARE FREE AREA SIZE.
4. ALL DUCTWORK SHALL BE SEALED PER THE REQUIREMENTS OF THE INTERNATIONAL MECHANICAL CODE. SEAL LOW PRESSURE SUPPLY, RETURN, OUTSIDE AIR, AND EXHAUST DUCTWORK FOR SMACNA SEAL CLASS A, SMACNA LEAKAGE CLASS 4, REFER TO SPECIFICATION SECTION 233113 FOR PRESSURE CLASSIFICATION SYSTEM REQUIREMENTS.
5. ALL LOW PRESSURE DUCTWORK MAINS AND DUCTS CONCEALED IN SHAFTS WILL BE SUBJECT TO PRESSURE TESTING PER SMACNA GUIDELINES (REGARDLESS OF DUCT PRESSURE CLASSIFICATION). SUPPLY AND EXHAUST MAINS IN SHAFTS, CORRIDORS INCLUDING TAPS TO ROOMS SHALL BE TESTED AS A COMPLETE SYSTEM.
6. ALL PIPING, DUCTS, VENTS, ETC., EXTENDING THROUGH WALLS AND ROOF SHALL BE FLASHED AND COUNTERFLASHED IN A WATERPROOF MANNER.
7. ALL PIPING AND DUCTWORK LOCATIONS SHALL BE COORDINATED WITH THE WORK UNDER OTHER DIVISIONS OF THE SPECIFICATIONS, TO AVOID INTERFERENCE.
8. TEST AND BALANCE CONTRACTOR WILL BE PROVIDED BY THE CONSTRUCTION MANAGER. THE MECHANICAL CONTRACTOR SHALL BE RESPONSIBLE FOR THE INSTALLATION OF ALL EQUIPMENT, VALVES, DAMPERS AND ACCESSORIES REQUIRED TO BALANCE THE SYSTEM WATER AND AIR FLOWS AS SPECIFIED. THE MECHANICAL CONTRACTOR AND SHALL ASSIST THE TEST AND BALANCE CONTRACTOR CONTRACTED BY THE CONSTRUCTION MANAGER DURING TESTING AND BALANCING. ALL MECHANICAL SYSTEMS SHALL BE BALANCED TO THE PERFORMANCE SPECIFICATIONS INDICATED ON PLANS, ANY EQUIPMENT OR SYSTEM FOUND TO BE DEFICIENT WILL BE CORRECTED AND RETESTED AT NO COST TO THE OWNER. TEST AND BALANCE CONTRACTOR WILL BE AABC OR NEBB CERTIFIED.
9. UPON PROJECT COMPLETION, THE MECHANICAL CONTRACTOR IS RESPONSIBLE FOR PROVIDING THE OWNER INSTALLATION INFORMATION IN ACCORDANCE WITH DIVISION 01 OF THE SPECIFICATIONS INCLUDING BUT NOT BE LIMITED TO: RECORD SUBMITTALS (WITH ANY SUBMITTAL REVIEW COMMENTS ADDRESSED), O&M MANUALS FOR EACH PIECE OF EQUIPMENT INCLUDING ALL SELECTED OPTIONS, THE NAME AND ADDRESS OF AT LEAST ONE SERVICE AGENCY, FULL CONTROL SYSTEM O&M AND CALIBRATION INFORMATION INCLUDING WIRING DIAGRAMS, SCHEMATICS, FULL SEQUENCE OF OPERATION, AND PROGRAMMED SETPOINTS.
10. PROVIDE A ONE YEAR WARRANTY FOR ALL WORK PERFORMED BEGINNING ON THE DAY THE SYSTEM IS COMPLETELY OPERATIONAL AND ACCEPTABLE BY SCO AND UNCC
11. PROVIDE MANUFACTURER'S RECOMMENDED CLEARANCES AROUND ALL EQUIPMENT FOR MAINTENANCE AND FILTER REMOVAL. (30"x30")
12. CONDENSATE DRAIN PIPING SHALL BE SCHEDULE TYPE "L" HARD DRAWN COPPER AND SHALL BE INSULATED PER THE SPECIFICATIONS. DRAINS FROM ALL COOLING COILS SHALL BE TRAPPED. DRAIN SIZE SHALL BE EQUIPMENT DRAIN CONNECTION SIZE (3/4" MINIMUM) WITH A MINIMUM DEPTH OF 4" OR 1.5 TIMES THE UNIT FAN TSP, WHICHEVER IS GREATER.
13. ALL REFRIGERANT PIPE SHALL BE NITROGENIZED ACR COPPER TUBE. SIZE, INSULATE, AND INSTALL REFRIGERANT PIPING PER MANUFACTURER'S RECOMMENDATIONS. PIPING INSTALLED OUTDOORS SHALL BE COVERED WITH AN OUTER ALUMINUM JACKET, SEALED WATERTIGHT.
14. ANY DEVICE REQUIRING A THERMOSTAT FOR CONTROL SHALL BE FURNISHED WITH A THERMOSTAT WHETHER INDICATED ON THE DRAWINGS OR NOT.
15. INSTALL THE TOP OF ALL THERMOSTATS, SENSORS, AND SWITCHES AT 4'-0" (MAXIMUM) ABOVE FINISH FLOOR. COORDINATE EXACT THERMOSTAT LOCATION WITH OWNER PRIOR TO INSTALLATION. ANY DEVICE ON A PERIMETER WALL SHALL BE MOUNTED ON A FOAM-FILLED ELECTRICAL BOX, WITH ALL GAPS BETWEEN BOX AND WALL SEALED TO PREVENT INFILTRATION.
16. MECHANICAL CONTRACTOR SHALL LOCATE EXHAUST FANS, OUTLETS, AND GAS FLUES A MINIMUM OF 20'-0" FROM ANY OUTSIDE AIR INTAKE.
17. DRYER VENT SHALL BE PROVIDED WITH A BACKDRAFT DAMPER. DRYER VENT SHALL NOT EXCEED A TOTAL EQUIVALENT LENGTH PER DRYER MANUFACTURER REQUIREMENTS WITH A 2.5' DEDUCTION FOR EACH 45° BEND AND A 5' DEDUCTION FOR EACH 90° BEND.
19. CHILLED WATER PIPING AND FITTINGS BELOW GRADE SHALL BE FACTORY PREINSULATED AS MANUFACTURED BY THERMACOR(OR EQUAL). CARRIER PIPE SHALL BE SCHEDULE 40 ASTM A53 GRADE B BEVELED FOR WELDING. INSULATION SHALL BE FOAMED IN-PLACE CLOSED CELL POLYURETHANE FOAM COMPLETELY FILLING THE ANNULUS BETWEEN THE CARRIER PIPE AND HPDE JACKETING. OUTER JACKETING SHALL BE HDPE.
20. ALL CHILLED WATER, AND HOT WATER PIPING SHALL MEET THE REQUIREMENTS OF SECTION 232113. ALL PIPING SHALL BE INSULATED PER SPECIFICATION SECTION 230700. ALL PIPING JACKETING, LABELING AND IDENTIFICATION SHALL MEET THE REQUIREMENTS OF SECTION 230553 (COLOR-CODED PVC JACKETING REQUIRED IN MECHANICAL ROOMS). MINIMUM PIPE SIZE SHALL BE 3/4".
21. ALL BRANCH CHILLED WATER AND HOT WATER PIPING SHALL PITCH UP IN DIRECTION OF FLOW WITH MANUAL AIR VENTS AT ALL HIGH POINTS AND 1/2" DRAIN VALVES AT ALL LOW POINTS.
22. PROVIDE UNIONS, FLANGES OR COUPLINGS AT CONNECTION TO ALL VALVES AND EQUIPMENT. DO NOT USE DIRECT WELDED OR THREADED CONNECTIONS TO VALVES, EQUIPMENT OR OTHER APPARATUS.
23. PROVIDE NON-CONDUCTING DIELECTRIC UNIONS WHENEVER CONNECTING DISSIMILAR METALS.
24. EQUIPMENT OPERATED DURING CONSTRUCTION SHALL USE FILTERED MEDIA TO PREVENT CONSTRUCTION DEBRIS FROM ENTERING COILS, DUCTWORK SYSTEMS, AIR TERMINALS ETC. AT COMPLETION OF CONSTRUCTION, MECHANICAL CONTRACTOR SHALL CLEAN ALL SYSTEMS WITH ALL CONTROL DEVICES WIDE OPEN AND REMOVE ANY REMAINING DEBRIS PRIOR TO TEST AND BALANCING. MECHANICAL CONTRACTOR SHALL REPLACE ALL FILTRATION WITH NEW FILTERS AT COMPLETION OF CONSTRUCTION. ANY DUCTWORK, AIR TERMINALS, AND/OR OTHER EQUIPMENT UPSTREAM OF FILTRATION SHALL BE CLEANED THOROUGHLY OF CONSTRUCTION DEBRIS BEFORE HANDING OVER TO OWNER. COORDINATE WITH OWNER/CM FOR ANY FILTER MAINTENANCE PROGRAM REQUIREMENTS.
25. ALL EQUIPMENT CONCRETE PAD SIZES FOR MECHANICAL EQUIPMENT SHALL BE CONFIRMED WITH APPROVED SHOP DRAWING SUBMITTALS AND ASSOCIATED UNIT MANUFACTURER ANCHOR LOCATIONS PRIOR TO FABRICATION/INSTALLATION. THE MECHANICAL AND PLUMBING CONTRACTORS SHALL COORDINATE THE EXACT LOCATION OF MECHANICAL EQUIPMENT HOUSEKEEPING PADS WITH THE FLOOR DRAIN LOCATIONS PRIOR TO INSTALLATION OF DRAINS.
26. ALL PIPING AND DUCTWORK SHALL BE SUPPORTED IN ACCORDANCE WITH THE SPECIFICATIONS, AND FURTHER SUPPORTS OR HANGERS SHALL BE PROVIDED AS REQUIRED TO PREVENT THE WEIGHT OF PIPING BEING PLACED ON EQUIPMENT.
27. DUCTWORK AND PIPING PASSING THROUGH/ABOVE ELECTRICAL ROOMS SHALL BE CLOSELY COORDINATED WITH THE ELECTRICAL CONTRACTOR. DUCTWORK OR PIPING SHALL NOT BE LOCATED ABOVE ELECTRICAL PANELS. PROVIDE DRAIN PAN UNDER PIPING LOCATED IN ELECT ROOM.
28. EXTEND ALL DRAIN LINES TO NEAREST FLOOR DRAIN OR AS INDICATED SO ROUTED AS TO AVOID INTERFERENCE WITH PASSAGEWAYS AND MAINTENANCE.
29. ALL VALVES AND SPECIALTIES SHALL BE LINE SIZE UNLESS NOTED OTHERWISE, USING ECCENTRIC REDUCERS (FLAT ON BOTTOM) WHENEVER PIPING TRANSITIONS ARE REQUIRED. AT INLINE PUMP SUCTION THE ECCENTRIC REDUCER SHALL BE FLAT ON TOP OF PIPE.
30. THIS PROJECT WILL BE COMMISSIONED IN ACCORDANCE WITH THE MANDATORY NORTH CAROLINA STATE CONSTRUCTION THIRD-PARTY COMMISSIONING REQUIREMENTS. MECHANICAL CONTRACTOR SHALL COORDINATE WITH THE OWNER'S COMMISSIONING AGENT AND PROVIDE ALL NECESSARY TIME, MATERIALS, AND PROCEDURES REQUIRED FOR A FULLY COMMISSIONED PROJECT. SEE COMMISSIONING SPECIFICATION SECTION 019113 IN PROJECT MANUAL FOR FURTHER INFORMATION.
31. ALL HYDRONIC SYSTEMS SHALL BE FILLED, PRESSURE FLUSHED, VENTED, AND CHEMICALLY TREATED PRIOR TO TURN-OVER AND CONNECTION TO EXISTING SYSTEM BY MEANS OF OPENING SYSTEM ISOLATION VALVES INSTALLED UNDERGROUND ADJACENT TO HRL BUILDING. DOCUMENTATION OF WORK SHALL BE PROVIDED AND VERIFIED PRIOR TO CONNECTION.
32. PRIOR TO TURNING ALL HYDRONIC SYSTEMS OVER TO THE MAIN CAMPUS DISTRIBUTION SYSTEMS, A SYSTEM FLUSHING AND CHEMICAL TREATMENT REPORT SHALL BE PROVIDED AND VERIFIED BY THE OWNERS COMMISSIONING AGENT.
33. CONTROLS VALVES, DAMPERS, AND BAS CONTROLLERS SHALL BE INSTALLED A MAXIMUM OF 2 FEET ABOVE THE CEILING AND WHERE INSTALLED ABOVE AN INACCESSIBLE CEILING A MINIMUM OF 2'x2' ACCESS DOOR SHALL BE PROVIDED. COORDINATE WITH ARCHITECTURAL PLANS FOR LOCATIONS AND CEILING TYPES.
34. VALVES MOUNTED 10' OR GREATER A.F.F SHALL BE PROVIDED WITH CHAIN OPERATORS.
35. MECHANICAL CONTRACTOR SHALL PROVIDE AND INSTALL ALL EQUIPMENT, CONTROLS, DUCTWORK, PIPING,ETC. FOR A FULLY FUNCTIONING MOCK-UP OF DESIGNATED FAN COIL UNIT HVAC CLOSET SELECTED BYOWNER/ARCHITECT. MOCK-UP SHALL HAVE THE ABILITY TO VERIFY SERVICE CLEARANCES, MAINTENANCE ACCESS, ETC. FOR ALL DEVICES IN THE ROOM INCLUDING THOSE PROVIDED BY OTHER TRADES. INCLUDING FIRESTOPPING SYSTEM OF PIPING RISER
36. PROVIDE ADDITIONAL OWNER STOCK FOR THE FOLLOWING ITEMS OF EACH PROVIDED SIZE AND CONFIGURATION: VERTICAL FAN COIL UNIT FAN WHEEL AND ASSOCIATED MOTOR
37. ALL MOTORS PROVIDED FOR EQUIPMENT IN MECHANICAL ROOM SHALL BE PROVIDED WITH A T.E.F.C. ARRANGEMENT.
38. ALL CLOSED LOOP PIPING SYSTEMS SHALL BE FLUSHED USING PRODUCT AND SERVICES BY RUP-4 SERVICE PROVIDER - CHEMTREAT

MECHANICAL SHEET INDEX

EQUIVALENT MANUFACTURERS LISTING

LISTING OF MANUFACTURER'S NAME DOES NOT GUARANTEE APPROVAL. ALL EQUIPMENT MUST MEET OR EXCEED QUALITY AND CAPACITIES OF SPECIFIED EQUIPMENT. FINAL APPROVAL WILL BE BASED ON EQUIPMENT SUBMITTALS. ANY MANUFACTURER NOT LISTED BUT WISHING TO BID THIS PROJECT SHALL
SUBMIT A WRITTEN REQUEST A MINIMUM OF 7 DAYS PRIOR TO BID DATE OR AS INDICATED IN THE SPECIFICATIONS, PRIOR APPROVAL IS REQUIRED FOR ALL MANUFACTURERS NOT LISTED.

(ALPHABETICAL ORDER)

FANS: COOK, GREENHECK, PENN, TWIN CITY
AIR DISTRIBUTION: CARNES, METAL*AIRE, NAILOR, PRICE, TITUS, KRUEGER
FIRE DAMPERS: GREENHECK, NAILOR, RUSKIN, POTTORFF, NCA, SAFE-AIRE
LOUVER: GREENHECK, RUSKIN, SAFE-AIR, POTTORFF, NAILOR
DUCTLESS SPLIT SYSTEMS: DAIKIN, MITSUBISHI, TRANE, PANASONIC
DDC CONTROLS (MFRS): JCI FX (AUTH FX DEALER-BACNET), SCHNEIDER INVENSYS (BACNET), ALLERTON (BACNET) (1)
PUMPS & HYDRONIC EQUIPMENT: ARMSTRONG, BELL & GOSSETT, PATTERSON, TACO
FAN COIL UNITS: CARRIER, INTERNATIONAL, TRANE, JOHNSON, DAIKIN, ENVIROTEC, ENG. COMFORT
ERV UNITS: ANNEXAIRE, ENGINEERED AIR, DESERT AIRE, DAIKIN, THERMAL CORP.
UNIT HEATERS: CARRIER, INTERNATIONAL, TRANE, YORK/JOHNSON, DAIKIN, MODINE
CABINET UNIT HEATERS: CARRIER, INTERNATIONAL, TRANE, YORK/JOHNSON, DAIKIN, MODINE
FINNED TUBE CONVECTORS: RITTLING, MODINE, STERLING, VULCAN

NOTE:
ALL COST ASSOCIATED WITH SUBSTITUTED EQUIPMENT TO COMPLY WITH BASIS OF DESIGN, INCLUDING PROVIDING MAINTENANCE ACCESS, CLEARANCE, PIPING, SHEET METAL, ELECTRICAL, REPLACEMENT OF SYSTEM COMPONENTS, BUILDING ALTERATIONS, ETC., SHALL BE INCLUDED IN THE ORIGINAL BASE BID. NO ADDITIONAL COST ASSOCIATED WITH SUBSTITUTED EQUIPMENT WILL BE APPROVED DURING CONSTRUCTION AND ALL COST WILL BE THE RESPONSIBILITY OF TH MECHANICAL CONTRACTOR.

ELECTRICAL/MECHANICAL DEMARCATION

REFER TO DETAIL 10/M-502 FOR MECHANICAL CONTRACTOR'S RESPONSIBILITIES RELATED TO ELECTRICAL DISCONNECTS, STARTERS AND WIRING OF MECHANICAL EQUIPMENT. ALL DISCONNECTS, STARTERS AND WIRING (LOAD SIDE OF DISCONNECTS) SHALL BE FURNISHED AND INSTALLED BY M.C. UNLESS OTHERWISE NOTED IN DETAIL 10/M-502. COORDINATE ALL ELECTRICAL REQUIREMENTS WITH E.C.
PRIOR TO ASSEMBLING SHOP DRAWING SUBMITTALS OR ORDERING EQUIPMENT.

MEASUREMENT & VERIFICATION NOTE

THIS IS A NORTH CAROLINA STATE CONSTRUCTION PROJECT WITH MANDATED MEASUREMENT AND VERIFICATION OF POST-OCCUPANCY WATER, AND ELECTRIC CONSUMPTION. DESIGN ANALYSIS AND PROJECTED CONSUMPTION WILL BE COMPARED TO ACTUAL USAGE AT BOTH 10 MONTH AND 12 MONTH POST-OCCUPANCY INTERVALS.

THE Cx AGENT AND OWNER WILL PROVIDE WATER AND ELECTRIC CONSUMPTION AND TRENDING DATA FROM THE MEASUREMENT AND VERIFICATION SYSTEM AT THE 10 MONTH AND 12 MONTH INTERVALS. THIS INFORMATION WILL BE PROVIDED TO THE ENGINEER FOR EVALUATION AND COMPARISON TO THE DESIGN ANALYSIS, ENERGY MODEL SIMULATION AND CONSUMPTION GOALS OF THE PROJECT.

RESULTS DEVIATING BY GREATER THAN 15% FROM PROJECTIONS WILL BE FURTHER ANALYZED AND A SYSTEM ADJUSTMENT REPORT PROVIDED FROM THE ENGINEER TO THE OWNER FOR SUGGESTED OPERATIONAL MODIFICATIONS.

COMMISSIONING NOTE

MECHANICAL CONTRACTOR SHALL COORDINATE WITH OWNER'S Cx AGENT AND PROVIDE ALL NECESSARY TIME, MATERIALS, AND PROCEDURES REQUIRED FOR A FULLY COMMISSIONED PROJECT.

WORK SCHEDULING NOTE

MECHANICAL CONTRACTOR SHALL SUBMIT, THROUGH THE GENERAL CONTRACTOR, A WRITTEN REQUEST FOR ANY AND ALL WORK REQUIRING A SHUT-DOWN OF ANY EXISTING OPERATING SYSTEM. ALL WORK REQUIRING A SHUT-DOWN MUST BE COORDINATED WITH AND APPROVED BY THE UNIVERSITY'S PROJECT CONSTRUCTION MANAGER PRIOR TO BEGINNING WORK. REQUEST MUST BE PROVIDED A MINIMUM OF ONE WEEK PRIOR TO REQUESTED SHUT-DOWN AND SHALL INCLUDE SPECIFIC TASK TO BE COMPLETED WITH SCHEDULE AND EXPECTED DURATION OF SHUT-DOWN.

Jenkins • Peer *Architects*
112 South Tryon Street, Suite 1300
Charlotte, North Carolina 28284
(t) 704/372-6665

KWK ARCHITECTS
103 West Lockwood, Suite 218
St. Louis, Missouri 63119
(t) 314/942-8810

STANLEY D. LINDSEY & ASSOC. ENGINEERING, PA
Civil Engineer
NC License # C-1863
1437 Harding Place, Suite 201
Charlotte, North Carolina 28204
(t) 704/333-3122

SKA CONSULTING ENG., PA
Structural Engineer
NC License # F-0508
4651 Charlotte Park Drive, Suite 150
Charlotte, North Carolina 28217
(t) 704/424-9663

OPTIMA ENGINEERING, PA
Mechanical, Electrical, Plumbing + Fire Protection Engineering
NC License # C-0914
1927 South Tryon Street, Suite 300
Charlotte, North Carolina 28203
(t) 704/338-1292

LANDDESIGN, INC.
Landscape Design
NC License # C-0658
223 North Graham Street
Charlotte, NC 28202
(t) 704/376.7777

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 17228 RONALD V. ALMOND
8/6/19

UNC CHARLOTTE
Charlotte, NC
RESIDENCE HALL PHASE XVI

SCO ID: 18-18333-02A

TAG	DESCRIPTION	DATE
1	ADDENDUM #1	8/26/19

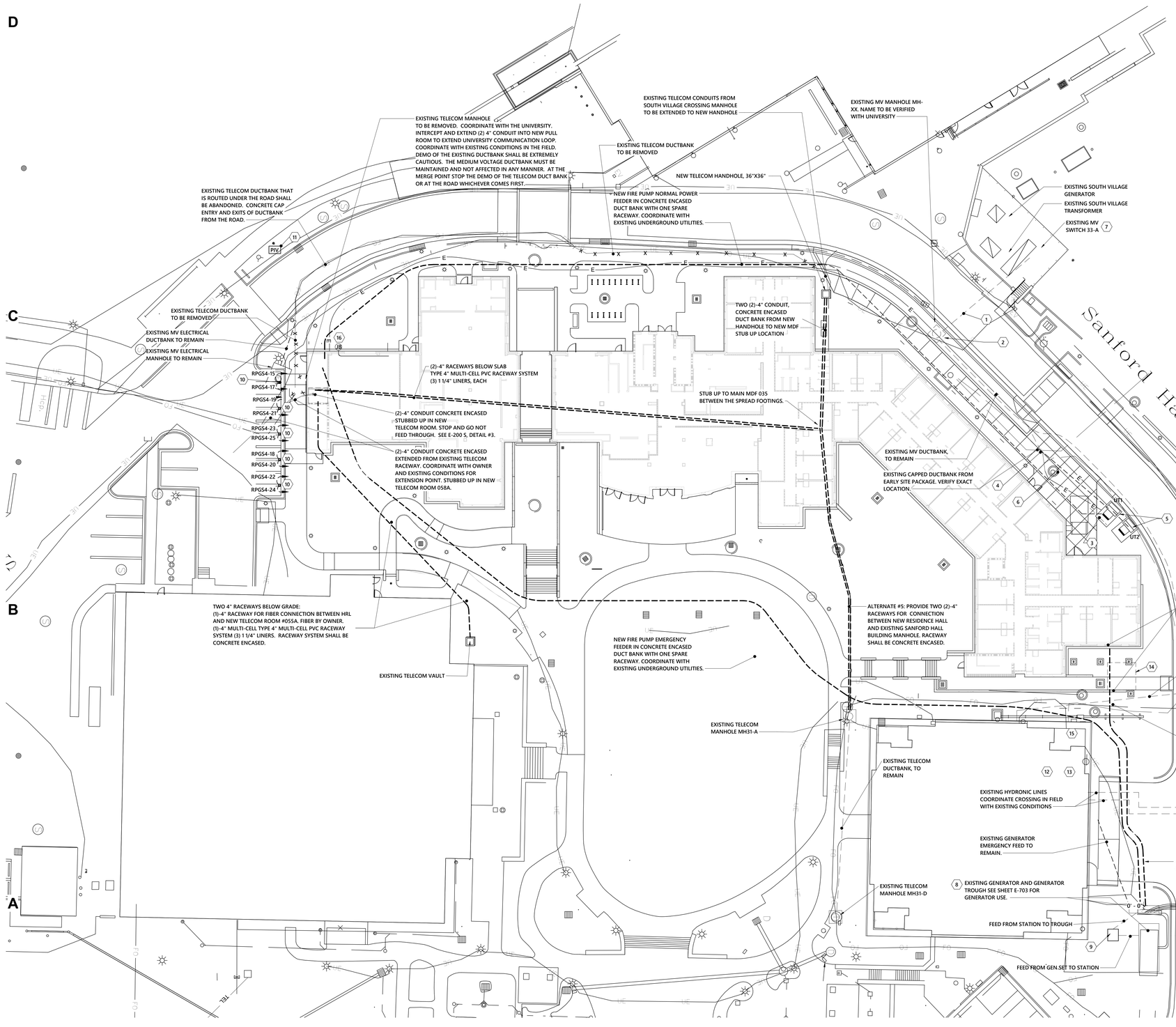
Project: 18NCC016
Drawn By: CAH
Designed By: CAH
Checked By: RVA
Date: 8/6/19

MECHANICAL LEGEND, NOTES AND SCHEDULES

PROJECT NORTH TRUE NORTH

BID SET

M-001



1 ELECTRICAL SITE PLAN

1" = 20'-0"

GENERAL NOTES:

1. PROVIDE ALL REQUIRED ACCESSORIES FOR MULTI-CELL RACEWAY SYSTEMS INCLUDING TERMINATORS, COUPLINGS, AND ADAPTERS. MULTI-CELL RACEWAY SYSTEM BASED ON CARLON MULTI-CELL PVC RACEWAY, OR EQUAL.
2. ALL TELECOMMUNICATION CONDUITS SHALL HAVE LONG SWEEPING BENDS WITH A 72" RADIUS PER UNC CHARLOTTE REQUIREMENTS. ALL CONDUITS WITHOUT THE MULTI-CELL INNER LININGS SHALL TRANSITION TO RIGID PRIOR TO PENETRATION OF THE FLOOR SLAB.
3. COORDINATE THE DEPTH OF THE TELECOMMUNICATION CONDUITS WITH THE GENERAL CONTRACTOR TO ALLOW ALIGNMENT WITH THE BLOCK OUTS IN THE FOOTINGS. NOTIFY THE ENGINEER AND OWNER OF ANY CONFLICTS PRIOR TO ROUGH-IN.
4. KNOW WHAT IS BELOW - CALL 811 - BEFORE YOU DIG.

KEYED NOTES: (X)

1. EXISTING MEDIUM VOLTAGE DUCTBANK WITH EXISTING MV CONDUCTORS TO SANFORD HALL. NEW MV CONDUCTORS FOR PHASE XVI BUILDING TO BE PULLED FROM EXISTING MV SWITCH 33-A, THROUGH EXISTING DUCTBANK AND EXISTING MANHOLE (NOTE 2), THROUGH EXISTING DUCTBANK, AND TO NEW DUCTBANK (NOTES 3,4).
2. EXISTING MANHOLE. MV CONDUCTORS TO SANFORD HALL TO REMAIN.
3. NEW MV DUCTBANK. SEE DETAILS SHEET E-701.
4. INTERCEPT AND CONNECT NEW MV DUCTBANK TO EXISTING MV DUCTBANK.
5. NEW MV TRANSFORMERS FOR FEED TO NEW PHASE XVI RESIDENCE HALL.
6. PROVIDE (3)-#2(15KV), (1)-#6 THWN-N TO FEED NEW PHASE XVI TRANSFORMER. SEE MV RISER ON E-701 FOR MORE DETAIL.
7. TERMINATE NEW MV FEEDERS ON EXISTING 150A FUSES IN EXISTING SWITCH 33-A FOR PHASE XVI BUILDING.
8. EXISTING 500 KW EMERGENCY GENERATOR SET TO REMAIN. PROVIDE MODIFICATIONS OF THE SYSTEM TO ALLOW ADDITION OF THE NEW CIRCUIT BREAKERS SHOWN ON THE RISER DIAGRAMS. COORDINATE THE REQUIRED MODIFICATIONS TO THE GENERATOR SYSTEM AND SOUND ATTENUATED ENCLOSURE WITH THE MANUFACTURER (NIXON POWER SERVICES COMPANY, CHARLOTTE) TO MAINTAIN ALL WARRANTY AND MAINTENANCE CONTRACTS.
9. LOCATION FOR NEW PERMANENT LOAD BANK AND OR NEW DUAL PURPOSE DOCKING STATION. SEE RISER DIAGRAM ON SHEET E-703. ALTERNATE NUMBER 8 IS DESCRIBED ON SHEET E-703.
10. CART CHARGING STATION. SUPPLY WITH TWO (2) 120 VOLT BRANCH CIRCUITS. SEE DETAIL OF CART CHARGING STATION.
11. POST INDICATING VALVE. COORDINATE EXACT LOCATION WITH THE INSTALLER. PROVIDE 1.25 INCH CONDUIT WITH CONNECTION TO THE FIRE ALARM SYSTEM.
12. EXISTING CHILLER LOCATED IN SANFORD HALL MECHANICAL ROOM WILL BE ABANDONED IN PLACE. VERIFY EXACT LOCATION. ELECTRICAL CONTRACTOR SHALL REMOVE POWER WIRING AND CONDUIT(S) BACK TO THE SERVING PANELBOARD(S). PLACE ASSOCIATED BREAKER(S) IN THE "OFF" POSITION AND UPDATE THE PANELBOARD SCHEDULE LABELING THE BREAKER(S) AS "SPARE". COORDINATE DISCONNECTING SCHEDULE WITH THE MECHANICAL CONTRACTOR AND OWNER.
13. EXISTING CONDENSER WATER PUMP LOCATED IN SANFORD HALL MECHANICAL ROOM WILL BE ABANDONED IN PLACE. VERIFY EXACT LOCATION. ELECTRICAL CONTRACTOR SHALL REMOVE POWER WIRING AND CONDUIT(S) BACK TO THE SERVING PANELBOARD(S). PLACE ASSOCIATED BREAKER(S) IN THE "OFF" POSITION AND UPDATE THE PANELBOARD SCHEDULE LABELING THE BREAKER(S) AS "SPARE". COORDINATE DISCONNECTING SCHEDULE WITH THE MECHANICAL CONTRACTOR AND OWNER.
14. EXISTING COOLING TOWER TO BE REMOVED. VERIFY EXACT LOCATION. ELECTRICAL CONTRACTOR SHALL REMOVE POWER WIRING AND CONDUIT(S) BACK TO THE SERVING PANELBOARD(S). PLACE ASSOCIATED BREAKER(S) IN THE "OFF" POSITION AND UPDATE THE PANELBOARD SCHEDULE LABELING THE BREAKER(S) AS "SPARE". COORDINATE DISCONNECTING SCHEDULE WITH THE MECHANICAL CONTRACTOR AND OWNER.
15. EXISTING BOILER FLUE VENT TO BE RELOCATED. VERIFY EXACT LOCATION. ELECTRICAL CONTRACTOR SHALL RELOCATE THE EXISTING BRANCH CIRCUIT AND DISCONNECT SWITCH TO THE NEW VENT FAN LOCATION. PROVIDE NEW WIRING TO THE UNIT. COORDINATE DISCONNECTING SCHEDULE AND NEW LOCATION WITH THE MECHANICAL CONTRACTOR. IF A RECEPTACLE IS NOT WITHIN THE CODE REQUIRED 25 FEET, PROVIDE A NEW WEATHER-RESISTANT GFI DUPLEX RECEPTACLE IN A WEATHERPROOF WHILE IN USE ENCLOSURE. WIRE TO NEAREST 20 AMP RECEPTACLE CIRCUIT WITH CAPACITY TO ACCEPT THE NEW LOAD.
16. LOCATION OF FUTURE IRRIGATION BACKFLOW PREVENTER. PROVIDE TWO (2) WEATHERPROOF JUNCTION BOXES EACH WITH A 1" EMPTY CONDUIT FROM THIS LOCATION STUBBED INTO MECHANICAL ROOM 058 ADJACENT TO THE CIRCUIT FOR IRRIGATION CONTROLS (RPGS4-26). ONE FOR FUTURE POWER WIRING AND ONE FOR FUTURE CONTROLS.

Jenkins • Peer *Architects*
112 South Tryon Street, Suite 1300
Charlotte, North Carolina 28284
(t) 704/372-6665

KWK ARCHITECTS
103 West Lockwood, Suite 218
St. Louis, Missouri 63119
(t) 314/942-8810

STANLEY D. LINDSEY & ASSOC. ENGINEERING, PA
Civil Engineer
NC License # C-1863
1437 Harding Place, Suite 201
Charlotte, North Carolina 28204
(t) 704/333-3122

SKA CONSULTING ENG., PA
Structural Engineer
NC License # F-0508
4651 Charlotte Park Drive, Suite 150
Charlotte, North Carolina 28217
(t) 704/424-9663

OPTIMA ENGINEERING, PA
Mechanical, Electrical, Plumbing + Fire Protection Engineering
NC License # C-0914
1927 South Tryon Street, Suite 300
Charlotte, North Carolina 28203
(t) 704/338-1292

LANDDESIGN, INC.
Landscape Design
NC License # C-0658
223 North Graham Street
Charlotte, NC 28202
(t) 704/376.7777

8/6/19

UNC CHARLOTTE
Charlotte, NC
RESIDENCE HALL PHASE XVI

SCO ID: 18-18333-02A

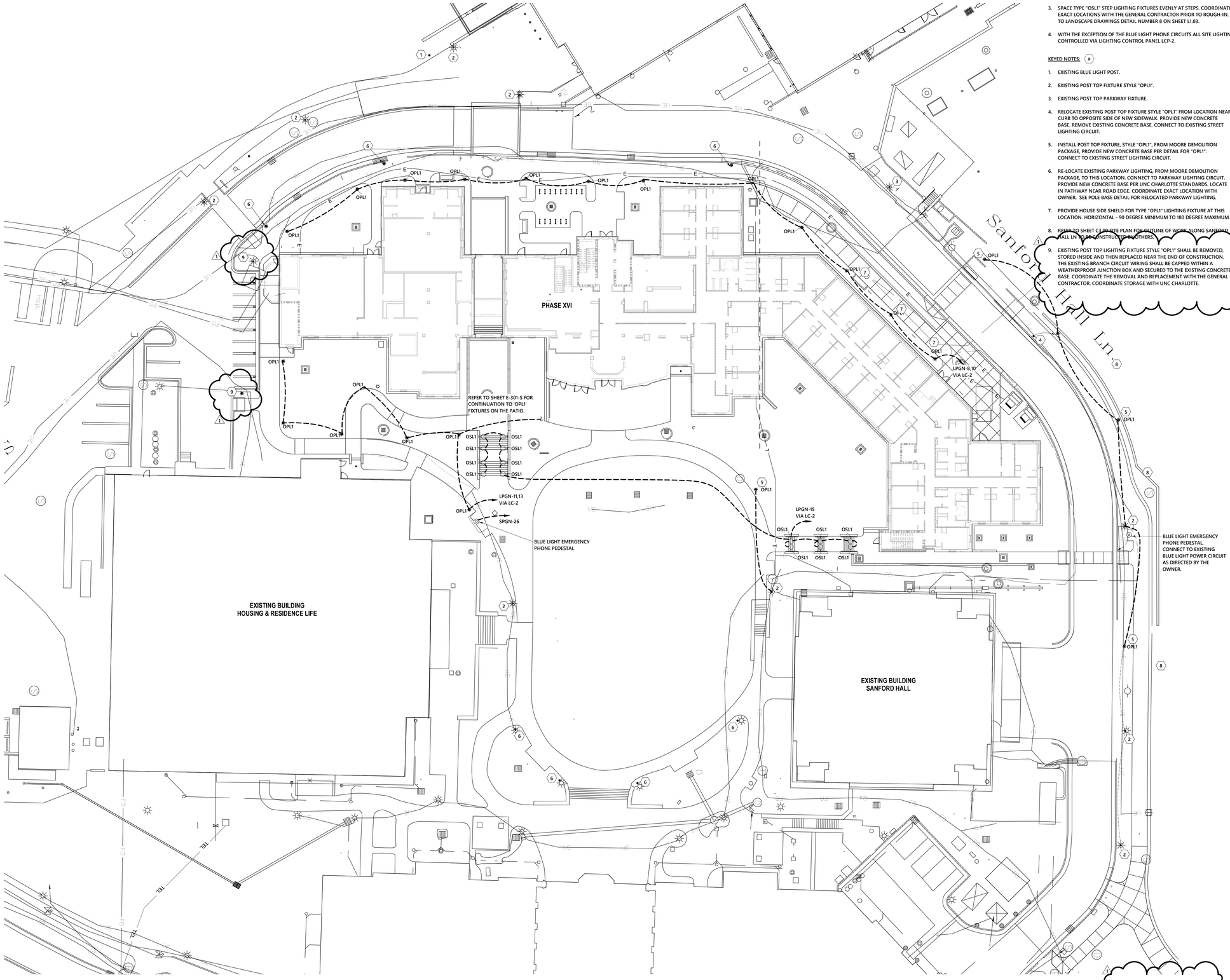
TAG	DESCRIPTION	DATE
1	ADDENDUM 1	8/26/2019

Project: 18NCC016
Drawn By: MH
Designed By: JR
Checked By: MM
Date: 8/6/19

ELECTRICAL SITE PLAN

BID SET

E-100



1 ELECTRICAL SITE PLAN - LIGHTING
1" = 20'-0"

GENERAL NOTES:

1. SEE BLUE LIGHT PHONE DETAIL ON SHEET E-004 FOR ADDITIONAL INSTALLATION REQUIREMENTS, INCLUDING COMMUNICATION CONDUIT AND CABLE.
2. SEE POLE BASE DETAIL "OPL1" FIXTURE FOR INSTALLATION REQUIREMENTS FOR FIXTURE TYPE "OPL1".
3. SPACE TYPE "OSL1" STEP LIGHTING FIXTURES EVENLY AT STEPS. COORDINATE THE EXACT LOCATIONS WITH THE GENERAL CONTRACTOR PRIOR TO ROUGH-IN. REFER TO LANDSCAPE DRAWINGS DETAIL NUMBER 8 ON SHEET L1.03.
4. WITH THE EXCEPTION OF THE BLUE LIGHT PHONE CIRCUITS ALL SITE LIGHTING IS CONTROLLED VIA LIGHTING CONTROL PANEL LCP-2.

KEYED NOTES: (#)

1. EXISTING BLUE LIGHT POST.
2. EXISTING POST TOP FIXTURE STYLE "OPL1".
3. EXISTING POST TOP PARKWAY FIXTURE.
4. RELOCATE EXISTING POST TOP FIXTURE STYLE "OPL1" FROM LOCATION NEAR CURB TO OPPOSITE SIDE OF NEW SIDEWALK. PROVIDE NEW CONCRETE BASE. REMOVE EXISTING CONCRETE BASE. CONNECT TO EXISTING STREET LIGHTING CIRCUIT.
5. INSTALL POST TOP FIXTURE, STYLE "OPL1", FROM MOORE DEMOLITION PACKAGE, PROVIDE NEW CONCRETE BASE PER DETAIL FOR "OPL1". CONNECT TO EXISTING STREET LIGHTING CIRCUIT.
6. RE-LOCATE EXISTING PARKWAY LIGHTING, FROM MOORE DEMOLITION PACKAGE, TO THIS LOCATION. CONNECT TO PARKWAY LIGHTING CIRCUIT. PROVIDE NEW CONCRETE BASE PER UNC CHARLOTTE STANDARDS. LOCATE IN PATHWAY NEAR ROAD EDGE. COORDINATE EXACT LOCATION WITH OWNER. SEE POLE BASE DETAIL FOR RELOCATED PARKWAY LIGHTING.
7. PROVIDE HOUSE SIDE SHIELD FOR TYPE "OPL1" LIGHTING FIXTURE AT THIS LOCATION. HORIZONTAL - 90 DEGREE MINIMUM TO 180 DEGREE MAXIMUM.
8. REFER TO SHEET C3.00 SITE PLAN FOR OUTLINE OF WORK ALONG SANFORD HALL LN TO BE CONSTRUCTED BY OTHERS.
9. EXISTING POST TOP LIGHTING FIXTURE STYLE "OPL1" SHALL BE REMOVED, STORED INSIDE AND THEN REPLACED NEAR THE END OF CONSTRUCTION. THE EXISTING BRANCH CIRCUIT WIRING SHALL BE CAPPED WITHIN A WEATHERPROOF JUNCTION BOX AND SECURED TO THE EXISTING CONCRETE BASE. COORDINATE THE REMOVAL AND REPLACEMENT WITH THE GENERAL CONTRACTOR. COORDINATE STORAGE WITH UNC CHARLOTTE.

Jenkins • Peer *Architects*
112 South Tryon Street, Suite 1300
Charlotte, North Carolina 28284
(t) 704/372-6665

KWK ARCHITECTS
103 West Lockwood, Suite 218
St. Louis, Missouri 63119
(t) 314/942-8810

STANLEY D. LINDSEY & ASSOC. ENGINEERING, PA
Civil Engineer
NC License # C-1863
1437 Harding Place, Suite 201
Charlotte, North Carolina 28204
(t) 704/333-3122

SKA CONSULTING ENG., PA
Structural Engineer
NC License # F-0508
4651 Charlotte Park Drive, Suite 150
Charlotte, North Carolina 28217
(t) 704/424-9663

OPTIMA ENGINEERING, PA
Mechanical, Electrical, Plumbing + Fire Protection Engineering
NC License # C-0914
1927 South Tryon Street, Suite 300
Charlotte, North Carolina 28203
(t) 704/338-1292

LANDDESIGN, INC.
Landscape Design
NC License # C-0658
223 North Graham Street
Charlotte, NC 28202
(t) 704/376.7777

8/6/19

UNC CHARLOTTE
Charlotte, NC
RESIDENCE HALL PHASE XVI

SCO ID: 18-18333-02A

TAG	DESCRIPTION	DATE
1	ADDENDUM 1	8/26/2019

Project: 18NCC016
Drawn By: MH
Designed By: JR
Checked By: MM
Date: 8/6/19

ELECTRICAL SITE PLAN - LIGHTING

PROJECT NORTH
TRUE NORTH

BID SET

E-101

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