



CITY OF HOUSTON

Sylvester Turner

Mayor



HOUSTON AIRPORT SYSTEM

George Bush Intercontinental ~ William P. Hobby ~ Ellington Airport

Mario C. Diaz
Director of Aviation

January 20, 2023

SUBJECT: Addendum No. 2

REFERENCE: Invitation To Bid (ITB) for the HOU ARFF Station #81 Phase 2-4 William P. Hobby Airport; Solicitation No. HHG-ARFF81-2023-006; Project No. 669

To: All Prospective Bidders:

This Addendum is issued for the following reason:

I. Extend the bid due date from **January 26, 2023, to February 2, 2023 at 10:30 A.M., (CST).**

II. Replace the following pages with the attached documents as outlined below.

1. Pages 15, Section 01210 - Cash Allowances.
2. Pages 19 and 20, Bid Form Part A.
3. Pages 21-25, Bid Form Part B.

III. Add the following pages with the attached documents as outlined below.

1. Section 01 91 13 - General Commissioning Requirements.
2. Section 01 91 15 – Building Enclosure Commissioning.
3. Section 01 91 17 – Building Enclosure Functional Performance Testing.
4. Section 23 08 00 – Commissioning of HVAC Systems.
5. Section 23 09 23 – Direct Digital Control Systems for HVAC.
6. Section 260800 – Commissioning of Electrical Systems.
7. Section 28 08 00 – Commissioning of Electronic Safety and Security.
8. B-6047 - Curtain Rod Specs.
9. B-5181 - Folding Shower Seat Specs.
10. SBADA-36-3F - ACORN Terrazzo-Ware Shower Base.
11. Drawing No.: A-603.2 - Door Schedule and Type.
12. Pavement Design Addendum Memorandum.
13. Flagpole Detail.
14. Limited Asbestos Survey.
15. Asbestos Survey.
16. Drilled Pier Reinforcement.
17. CaptiveAir Kitchen Hood Drawings.
18. COXREELS SH, MP, & HP Series Page.
19. Pavement Design Report.
20. Drawing No.: E-201.2 – Electrical Power Plan – Area A.
21. Proposed Sanitary Sewer Line Route.

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22. Drawing No.: G-004.2 - Life Safety Plans.
23. Drawing No.: A-100.2 - Architectural Overall Floor Plan.
24. Drawing No.: A-110.2 - Architectural Overall Roof Plan.
25. Drawing No.: A-142.2 - Partial Furniture and Equipment Plan – Area B.
26. Drawing No.: A-201.2 - Exterior Elevations.
27. Drawing No.: A-202.2 - Exterior Elevations.
28. Drawing No.: A-203.2 - Exterior Elevations.
29. Drawing No.: A-300.2 - Building Sections.
30. Drawing No.: A-701.2 - 3D Views.
31. Drawing No.: A-702.2 - 3D Views.

IV. To Respond to Questions.

1. **Question:** The bid documents mention good faith efforts in several locations. In the pre-bid we heard that meeting the DBE goal was a “Pass/Fail” effort, meaning if you do not meet the goal your bid will not be considered. Please clarify.

Response: Bidders are expected to meet the goal. However, if the goal is not met, Bidder's must document on the provided form all (good faith) efforts that were attempted to engage DBEs for subcontracting opportunities. Based on those attempts, HAS OBO will evaluate if the Bidder met the goal; evaluate all attempts to meet the goal; and whether the efforts meet the standard for good faith. Bidders must make every effort to meet the stated goal with certified DBEs. Please note, other certifications such as MBE and WBE, do not qualify as DBE.

2. **Question:** Section 01210 shows 4 cash allowance items totaling \$825,000.00. Section 00410B-3 shows 1 cash allowance item for \$10,000.00. Please clarify.

Response: Please refer to Section 01210 - Cash Allowance (Revised) and Bid Form 00410B-3 (Revised). Cash allowances are \$35,000 of building permit, \$300,000 of permanent gas & electrical service, \$15,000 of permanent telephone service, \$475,000 of FF&E equipment and \$50,000 Moving Allowance. Total cash allowance is \$875,000.00

3. **Question:** Section 01450 calls for the Contractor to have QA/QC, however several City of Houston Specifications state that testing is paid for by the Owner. Section 01455 was not definitive. Can you clarify who performs the geotechnical testing?

Response: Quality Assurance (QA) testing for measurement and acceptance for payment is performed via a third party by HAS. Refer to Section 01455 City's Acceptance Testing. Quality Control (QC) testing is performed by the Contractor. Geotechnical Testing has been performed by HVJ Associates. See Pavement Design Report and Addendum dated 12/10/20 attached.

4. **Question:** The specified waterline material, Ductile Iron, is currently 8-10 months delivery time. Can HAS suggest a different waterline material that is more readily available?

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Response: A variance request must be submitted to the City of Houston and approved to allow for the material change. Submit a substitution request for approval and a cost & schedule difference if there is one.

5. **Question:** We request additional time for questions and a bid date extension.

Response: Effective with this Addendum (No. 2) the bid date is extended to February 2, 2023.

6. **Question:** ADS drawings were included in the plans for the design and materials for the underground detention system. A note on the drawing's states "or approved equal". Do you have a list of approved materials or vendors?

Response: Contech is an approved equal.

7. **Question:** Sheet C-502 Paving/Joining notes call for 4" thick HMAC at the driveways and dumpster pad. Can the driveway limits be identified?

Response: All areas that are not parking spaces are considered driveway areas.

8. **Question:** We were unable to locate the Geotechnical Report in the Bid Documents provided.

Response: Geotechnical Testing has been performed by HVJ Associates. See Pavement Design Report and Addendum dated 12/10/20 attached.

9. **Question:** Sheet CS100.2 Note #27 – We were unable to locate this instance on the plans.

Response: This is a duplicated keynote and has the same intent as keynote 16.

10. **Question:** Sheet CD 100.2 Note #31 shows 89 LF, This quantity does not appear to include the ditch removal at the driveway on the bottom right of the plan.

Response: The driveways are 67' and 24' wide. If you include an extra 3 ft on both sides, it will be about a total of 105 LF.

11. **Question:** Please advise if 2 weeks is enough time between phases for the ARFF equipment and personnel to relocate to the new location for that phase. If more time is needed, will these days be considered towards the 865 calendar days?

Response: HFD has confirmed that two (2) weeks is sufficient for relocation between phases. If more time is needed, these will be considered towards the 865 calendar days.

12. **Question:** Please provide specification sections for TA 07 Reversible Solid Phenolic Folding Shower Seat, TA 10 shower curtain rod, and TA 14 Frameless Shower Door.

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Response: See the attached cut sheet. Folding Shower Seat Bobrick B-5181, Curtain Rod B-6047, or approved equal. Commercial grade frameless shower door manufacturer: Shower Doors of Houston, Back-to-Back handle Shower Bar, Beveled with Full Back Plate Door Hinges, Pattern Glass from full range of glass options. All hardware for shower door will be stainless steel - satin finish Web Site: Houstonshowerdoors.com, Ph 281-220-6886.

13. **Question:** Please provide specification section 10 28 19 Toilet & Shower Enclosures. It is listed in the table of contents but not provided.

Response: See attached cut sheets. Acorn SBADA-36-3F and SBR-4236-3F & SBR6036-3F Terrazzo shower base or approved equal. GC to coordinate recessed slab to receive shower bases.

14. **Question:** Please provide locations for fire extinguisher cabinets and mounted fire extinguishers. Only 1 fire extinguisher is shown on Life Safety Plans.

Response: See attached sheet G-004.2 for locations of FE = Bracket Mounted Fire Extinguishers and FEC = Fire Extinguishers & Cabinets.

15. **Question:** Please provide a flagpole foundation detail.

Response: Please see Flagpole Detail sketch provided in the attachments.

16. **Question:** Reference 01110-1 Summary of Work Section 1.03 F, the construction budget is stated to be \$12,000,000. Please confirm this budget.

Response: The estimated project budget is \$14M. Please refer to the response provided in Question #2 regarding cash allowances.

17. **Question:** Please confirm if this project will proceed if all the bids received exceed this budget.

Response: Confirmation can only be provided through City Council award approval.

18. **Question:** Plans call for rainscreen system, but rainscreen doesn't show up in specs. Can you verify what is being considered for the rainscreen siding system and where this system is shown as specified on the plans?

Response: BOD: Centria, Rainscreen, Concealed Fastener System, or approved equal.

19. **Question:** Flat Panel Display (Unmarked room) - Drawing TA-102.2, illustrates a "Future 55" FPD" in what is described on Drawing TA-122.2 as an "Outdoor Area". Specification Section 274000 does not provide information on scope for this location. Please clarify if AV Contractor is to provide rough-in and articulating wall mount or provide rough-in only at this location. If articulating mount is required, please specify make & model.

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Response: Provide backboxes, conduit and backing per Sheet TA-403.2 Detail 1. Mount and Display will be provided by the owner.

20. **Question:** 90 Second Timer & Relay - Plans Section TA-602.2, One-Line Drawing Diagram (3), the one-line drawings illustrate a "90 Second Timer" and a "Relay" without reference to the AV symbol Legend located on Plans Section TA-601.2. No indication of them can be found on Specification Section 274000. Please specify if the AV Contractor is to provide and install the "90 Second Timer" and Relay". Also please specify desired manufacturer and model # for "90 Second Timer" and "Relay".

Response: Relay models are dependent on selected Strobes, Bay Doors and Lighting Panels provided by others. Coordinated requirements with respective contractors and submit appropriate relays from Altronix R Series or similar. 90 Second Timer - Altronix 6062 Multipurpose Timer or similar.

21. **Question:** The drilled piers schedule is missing, please issue.

Response: The pier length is indicated on the foundation plan. Attached is a detail for the reinforcement.

22. **Question:** Please clarify if a TPO roofing system is required per the keynotes on sheets A-111.2, A-112.2 and A-113.2 or PVC roofing system per the specifications.

Response: KEE TPO membrane or approved equal.

23. **Question:** Please identify the different metal panel rainscreen systems on exterior elevations. Keynotes call for metal panel rainscreen system at different locations with the same note per sheet A-203.2

Response: See attached color coated Floor Plan, Roof Plan and Sections. Sheets include A-100.2, A-110.2, A-201.2, A-202.2, A-203.2 & A-300.2.

24. **Question:** How many EV Chargers does this project call for?

Response: There is currently (1) EV charging station. RE:E201.2 (Note 12).

25. **Question:** What are the distances of the EV parking spots from the electrical boxes?

Response: RE: E201.2, E202.2. The charging station is approximately 200' to panelboard 'LFG'.

26. **Question:** Contracting-024100-"Please confirm that the owner will be considered the generator of any existing hazardous waste encountered at the site and will sign all manifests.

Response: Confirmed.

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27. **Question:** Environmental-00340-"Section 00340 references lead and asbestos survey reports, but these are not found. Please provide.

Response: Attached is the Limited Asbestos Survey Report by Freese and Nichols, Inc. dated 01/13/21 and the Asbestos Survey by EFI Global dated 04/22/20.

28. **Question:** Contracting-00700 00701-"Section 00700 is the General Conditions and section 00701 is FAA General Provisions. In the event of a conflict, which takes precedence.

Response: In the event of a conflict in the documents, the more stringent condition shall apply.

29. **Question:** Geotech-00320-"Section 00320 references a Geotech report, but it is not found. Please provide.

Response: Geotechnical Testing has been performed by HVJ Associates. See Pavement Design Report and Addendum dated 12/10/20, attached.

30. **Question:** Contracting—"Contractor requests a provision containing a mutual waiver of consequential damages between Owner and Contractor.

Response: Denied. Refer to General Conditions of the Contract 00700 for applicable Contract provisions.

31. **Question:** Contracting—"Contractor requests confirmation that Owner's Liquidated Damages are Owner's sole and exclusive remedy for Contractor caused delay.

Response: Please refer to the response provided in Question #30.

32. **Question:** Contracting—"Given the current market conditions, Contractor requests a provision providing Contractor relief from Owner for legitimate and substantiated escalation costs.

Response: Please refer to the response provided in Question #30.

33. **Question:** Contracting—"Given the current market conditions, Contractor requests time and money relief from Owner due to legitimate and substantiated material shortages.

Response: Please refer to the response provided in Question #30.

34. **Question:** Contracting-00700—"Contractor requests confirmation that the Agreement and General Conditions control in the event of a conflict between the Agreement, General Conditions, and the FAA General Provisions.

Response: In the event of a conflict in the documents, the more stringent condition shall apply.

35. **Question:** Contracting-00520—"Considering the Scope of Work and Contractor's limited permission by Owner to conduct site investigation, Contractor requests Agreement, Sections 5.1.4 and 5.1.5, and General Conditions, Section 4.3.5.1.2 be stricken.

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Response: Please refer to the response provided in Question #30.

36. **Question:** Contracting-00700-“Contractor requests that General Conditions, Section 5.2.4, requiring Contractor to release retainage to Subcontractors even if Owner continues to withhold retainage from Contractor, be stricken.

Response: Please refer to the response provided in Question #30.

37. **Question:** Contracting-00700-“Contractor requests that General Conditions, 13.2.1 provide for mutual disclaimer of personal liability for both the Owner and Contractor.

Response: Please refer to the response provided in Question #30.

38. **Question:** Architectural-G-003.2-“The phasing shown on drawing G-003.2 references construction of modular building in Phase 1 (Package 1). Nothing in the document can be found regarding modular buildings and the drawings are marked as package 2. Please confirm that modular buildings are not part of this project.

Response: Modular buildings are not part of this contract.

39. **Question:** Demolition-G-003.2 & CD100.2-“From the phasing on drawing G-003.2 it seems that demolition of the existing building will need to be done in phases. Demolition plan CD100.2 does not provide any sequencing of demolition. Also, there isn’t any information regarding temporary construction need for phasing. Please provide additional information regarding the sequence of demolition and temporary construction requirements.

Response: Sequence of demolition should follow and suit the phasing depicted in drawing G-003.2.

40. **Question:** Architectural-“Please specify if signage will be CFCI, OFOI, or OFCI.

Response: CFCI.

41. **Question:** Plumbing-221116-“Will press type fittings be permitted for copper water piping?

Response: No. Press type fittings are not acceptable.

42. **Question:** Plumbing-221316, P-001.2-“Spec 221316 subsections 2.2 B.3 and C.3 states PVC may be utilized if permitted by local codes and the owner. The Piping Schedule on P-001.2 calls for cast iron. Please confirm all soil, waste, and vent piping above ground is to be cast iron per the piping schedule.

Response: Waste and vent piping above ground shall be cast iron.

43. **Question:** Plumbing-Spec 221119, P-001.2-“Spec 221119 section 2.11 B. discusses trap seal primer systems while Note 22 on P001.2 states that all floor drains should either be primed or utilize trap guards. Please clarify that trap guards are acceptable in lieu of trap primer systems.

Response: Trap guards are acceptable.

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44. **Question:** Plumbing-P-102.2-“P-102.2 denotes a 1,000-gallon Sand/Oil Separator and 500-gallon grease interceptor but these items are not listed in the Plumbing Schedule. Please provide details and specifications for these items.

Response: Re: A1/P-401.2 for sand oil interceptor. Grease interceptor shall be similar to Park Equipment Company model GT-750.

45. **Question:** Plumbing-P-501.2-“Please provide details or specs for the filters listed in the description for AC-1.

Response: Per specification Section 22 15 00.

46. **Question:** HVAC-M-002.2-“Note AL states the MC is to obtain all necessary permits and pay all legal fees. Please clarify the permits required and the fees referenced.

Response: Contractor will obtain all permits required by Building Standard Group (BSG).

47. **Question:** HVAC-M-002.2, 230593-“Note BL denotes that TAB must be performed by a firm independent from the design. It is unclear whether the TAB firm can be subcontracted to the HVAC firm or if this must be a first-tier subcontractor to the GC. Please clarify.

Response: TAB contractor shall be under GC and AABC certified.

48. **Question:** Fire Protection-211100, F001.2-“Section 2.1 C.1 states fire suppression piping shall be schedule 40 black steel. Section C.1.a. lists schedule 10 as acceptable for sizes 2-1/2” and larger. Note O on F001.2 states schedule 10 piping is acceptable for sizes 2-1/2” and larger. Please confirm Schedule 10 is acceptable.

Response: Schedule 10 piping is NOT acceptable.

49. **Question:** Fire Protection-G-003.2-“The existing living quarters will be demolished in the first part of Phase 2 leaving the existing Apparatus Bays at the east end to be used during construction of the new residential quarters in the second part of Phase 2 and the construction of the new West ARFF Bays at the west end of the building. It is assumed that this phasing will leave the existing east apparatus bays without fire suppression. Please confirm fire suppression will not be required in the existing east apparatus bays after the demolition of the existing living quarters.

Response: Fire suppression is still required in the existing apparatus bays after demolition of the existing living quarters.

50. **Question:** Plumbing-P121.2-P123.2, P501.2-“Roof drains appear to be indicated with the tag RD-1 while overflow drains appear to be indicated with the tag OD-1 on the plumbing roof plans. Neither RD-1 or OD-1 is included in the schedules on P501.2. Please update the plumbing schedule to include descriptions of RD-1 and OD-1.

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Response: RD-1: JR Smith 1010-AD-C2-R; OD-1: JR Smith 1070-Ad-C2-R.

51. **Question:** Plumbing-P601.2-“The gas piping at the auto shutoff valve and griddle/range is shown in a dotted line. Please clarify what this dotted line is meant to signify.

Response: Gas lines in kitchen shall be sleeved per city code.

52. **Question:** Plumbing-P602.2-“It appears that the storm drain and overflow drain lines tie together above grade before exiting the building through a combined drain. Please confirm this is correct and there is no requirement for the overflow drains to discharge to the exterior of the building above grade.

Response: Install storm drain piping systems per P-602.2.

53. **Question:** HVAC-M102.2-“Note BK on M002.2 denotes a requirement for secondary drain pans for all ceiling suspended AHUs, FCUs, Heating coils, etc. located above occupied spaces. Does this also apply to roof mounted equipment such as the RTUs?

Response: Secondary drain pans are not required for RTU's.

54. **Question:** HVAC-M403.2, Spec 233100-“Spec 233100 subsection 2.7 includes a ductwork system application table that lists stainless steel as the material for kitchen hood exhaust duct. Detail C1 on M403.2 shows that the kitchen hood exhaust should be 16 ga welded black steel with 1 hour fire wrap. Please clarify the appropriate material and covering for the kitchen hood exhaust.

Response: Both stainless steel and 16 ga welded black steel with 1-hour fire wrap are acceptable for the kitchen hood grease exhaust system.

55. **Question:** Plumbing-P-102.2-“The main sanitary in the corridor between Dorm 122 and Officer Room 123 is marked with “??” in several locations. Please clarify what this marking is meant to designate.

Response: “??” Shall be replaced with Y fitting and 4”SS.

56. **Question:** Plumbing-P-102.2-“The sanitary sewer serving the Mechanical room and Compressor Room is drawn outside the building footprint and there is a fitting that seemingly indicating flow to the north. Is it acceptable to assume this is a simple diagrammatical mistake? Is it also acceptable to assume this line can be located within the building footprint?

Response: Install sanitary sewer piping system as shown. The flow shall go south.

57. **Question:** Openings-A-603.2-“On the door schedule, there are fire-rated doors and other doors that don't list the door type.

Response: See attached sheet A-102.2 for clarifications.

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58. **Question:** Openings-A-603.2-“ON the door schedule, what is the N/P and N/Q material type?”

Response: Door numbers 116B, 124C, 127B, 121C, 140B & 141B do not apply. Doors will be struck and deleted from door schedule. See the attached sheet A-603.2 for additional clarifications.

59. **Question:** Plumbing-P111.2, P112.2, P113.2, P501.2-“P112.2 Note 19 indicates ¾” hot water recirculation to the inlet of HWCP-1 in the Multipurpose Room 109, however, the pump is not tagged. No hot water recirculation piping is shown leaving the room going back to the water heaters. No hot water recirculation piping is shown throughout the building. P111.2 Note 4 also indicated ¾” hot water recirculation to the inlet of HWCP-1 but there is no tag for this pump. There is a note in the pump schedule on P-501.2 discussing pumps for future but it is unclear to which pump this refers. If a hot water recirculation system is not intended to be included, please confirm. If a complete hot water system is to be included, please clarify and provide direction. Where will HWCP-1 be located? If multiple pumps are to be located remotely from the water heaters as potentially indicated, please provide details on the piping from the pumps is to be routed back to the water heaters and connected.

Response: There are two water heaters (GWH-1 & 2) and one circulating pump (HWCP-1) located in the mechanical room. Re: C1/P402.2 for water heater piping detail. Run ¾” HWR lines from the end of hot water supply lines to the mechanical room and connect to the inlet of the HWCP-1 per notes on the plumbing plans.

60. **Question:** Architectural -A-102.2/ A-605.2-“Dwg. A-102.2 General Notes letter “N” states “Toilet accessories – See sheet A-605.2 for toilet accessories and product model numbers.” However, sheet A-605.2 doesn’t list any items, model numbers or manufacturers. Please specify what items will be CFCI and specify model numbers and manufacturers.

Response: See issued Specification Section 10 28 00 Toilet Accessories.

61. **Question:** Is Scranton Products a qualified substitution for locker/partition products?

Response: Substitution requests to be submitted at the time of the bid submission and as part of the submission packet. Substitutions must meet current HAS Design Criteria Manual requirements.

62. **Question:** Is QuickServ a qualified substitution for aluminum pass-thru sliding service window?

Response: Substitution requests to be submitted at the time of the bid submission and as part of the submission packet. Substitutions must meet current HAS Design Criteria Manual requirements

63. **Question:** Commissioning Specifications.

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Response: Included are specification sections to be incorporated as follows: SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS, SECTION 01 91 15 BUILDING ENCLOSURE COMMISSIONING, SECTION 01 91 17 BUILDING ENCLOSURE FUNCTIONAL PERFORMANCE TESTING, SECTION 23 08 00 – COMMISSIONING OF HVAC SYSTEMS, SECTION 23 09 23 – DIRECT-DIGITAL CONTROL SYSTEMS FOR HVAC, SECTION 260800 COMMISSIONING OF ELECTRICAL SYSTEMS, and SECTION 28 08 00 – COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY.

64. **Question:** With the due date being moved back until the end of January we have decided to bid on this project. I realize the pre-bid meeting, job walk, and question deadline was originally the 1st half of November. With the extended date will you be scheduling a second job walk date? Also, will there be a new deadline for questions?

Response: No, there will not be a second job walk or a new deadline for questions.

65. **Question:** Please provide a building signage schedule and signage details if the building signage is to be provided and installed by the contractor.

Response: See specification Section 10 14 23.16 for Interior signage. Follow HAS Wayfinding and Building signage standards. Building Signage & Graphics allowance is provided for the exterior wall mounted “81” signs. Three dimensional back lit brushed stainless-steel numbers shall be designed with to withstand wind loads. G.C. to coordinate wall blocking requirements and anchorage. Building Signage & Graphics allowance is provided for the precast monument sign show at the lower right corner of the new ARFF building. See electrical sheet E-003.2 for wiring and lighting. G.C. to provide deferred submittal by a licensed signage company with wayfinding signage package.

66. **Question:** Please Confirm what panels are to be installed and where for exterior siding. The Specifications call for insulated wall panels, but plans do not specify these panels.

Response: Formed Metal panels and Rainscreen wall system should be utilized throughout. Per 2015 IECC, Continuous Insulation will be required at face of exterior metal framed walls of a minimum of R-5ci and at Mass walls a Continuous Insulation of a minimum of R-5.7ci will be required.

67. **Question:** Please clarify if there is any schedule requirement for the Storm Tech system as shown in CJ-100.2. (Phasing or completion date).

Response: Contractor should follow project phasing. There is no requirement on when this needs to be installed by the underground detention manufacturer. Temporary storm water line shall be installed and connect to new proposed lift station. Refer to attached sketch for proposed routing.

68. **Question:** Please include exterior building elevation symbols on floorplans.

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Response: Sheet A-110.2 will be updated to include the exterior elevation symbols. PDF drawing provided.

69. **Question:** Are their site plans/electrical drawing of where the EV Chargers will be located?

Response: RE: E201.2 (Note 12). The charging station is located in the "Carport". Refer to attached sketch for proposed location.

70. **Question:** Architectural--"Please provide specs calling out interior/exterior signage, and provide material, thickness, dimension/mounting details, along with pictograms and signage plan for drawings.

Response: Please refer to the response provided in Question #65.

71. **Question:** Plumbing-P-111.2-"Plan notes indicate compressed air piping to hose reels in several locations, but compressed air hose reels are not listed in the equipment schedule. Please clarify who is responsible for furnishing and installing these hose reels. If hose reels are to be furnished and installed by Division 22, please provide specifications and details for this work.

Response: Compressed air hose reels will be furnished by G.C. Refer to attached cut-sheets for preferred manufacturer of hose reels (Model SH-N-3100). Substitutions can be requested for an approved equal product.

72. **Question:** Plumbing-P-111.2-"Plan notes indicate cold water piping to water reels in several locations, but water reels are not listed in the equipment schedule. Please clarify who is responsible for furnishing and installing these reels. If reels are to be furnished and installed by Division 22, please provide specifications and details for this work.

Response: Water reels will be furnished by G.C. Refer to attached cut-sheets for preferred manufacturer of hose reels (Model SH-N-3100). Substitutions can be requested for an approved equal product.

73. **Question:** Plumbing-P101.2, P102.2, P103.2, G-003.2, AD100.2, AD101.2-"The sanitary sewer main flows through the new apparatus bays and exits the at the east end of the building. The phasing plans show the existing apparatus bay remaining until Phase 4. This would mean the sanitary sewer serving the new residential quarters and new ARFF bays at the west side will not be functional prior to construction of the new east ARFF bays. Please confirm the new ARFF bays are not expected to be operational prior to the completion of the east ARFF Bays. If the new Residential Quarters are expected to be used prior to completion of the east ARFF bays, please provide direction for any required temporary services, potentially including temp sewers and lift stations.

Response: New Residential Quarters are expected to be occupied prior to construction of east ARFF bays. Temporary storm water line shall be installed and connected to the new proposed lift station. Please refer to P101.2, P102.2, P103.2, G-003.2, AD100.2, and AD101.2 drawings provided in the bid documents for proposed routing.

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74. **Question:** HVAC-M112.2, M601.2-"Page M112.2 shows two pieces of equipment tagged FUN-1 and FUN-2. These items are not listed in any schedule on M601.2. Please provide specs and/or a description of FUN-1 and FUN-2.

Response: Kitchen hood supply and exhaust fans, FUN-1 & FUN-2, will be furnished and installed by G.C. Please refer to the attached kitchen hood package for exhaust fan details.

75. **Question:** HVAC-M102.2, M601.2-"Note 17 on M102.2 states that a UL Listed Type 1 kitchen hood is to be provided. This is not listed in the schedules on M601.2. Please provide specs and/or a detailed description of the kitchen hood.

Response: Please refer to the response provided in Question #74.

When issued, Addendum shall automatically become part of the solicitation documents and shall supersede any previous specification(s) and/or provision(s) in conflict with the Addendum. Addendum will be incorporated into the Agreement as applicable. It is the responsibility of the bidder(s) to ensure that it has obtained all such letter(s). By submitting a bid on this project, bidder(s) shall be deemed to have received all Addendum and to have incorporated them into their bid.

If further clarification is needed regarding this solicitation, please contact Senior Procurement Specialists, Jorge Ardines, and David Martinez via email at jorge.ardines@houstontx.gov and david.martinez@houstontx.gov.

DocuSigned by:

Sonya Hunter-Reed

EE681BB96520413

Cathy Vander Plaats
Aviation Procurement Officer
Houston Airport System

CVP/dm

cc: Alfredo Oracion
Dallas Evans
Solicitation File

Attachments:

1. Revised Section 01210 - Cash Allowances – Pages 15.
2. Revised Bid Form Part A – Pages 19-20.
3. Revised Bid Form Part B – Pages 21-25.
4. Section 01 91 13 - General Commissioning Requirements.
5. Section 01 91 15 – Building Enclosure Commissioning.
6. Section 01 91 17 – Building Enclosure Functional Performance Testing.
7. Section 23 08 00 – Commissioning of HVAC Systems.
8. Section 23 09 23 – Direct Digital Control Systems for HVAC.
9. Section 260800 – Commissioning of Electrical Systems.

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Solicitation No. HHG-ARFF81-2023-006
Project No. 669

10. Section 28 08 00 – Commissioning of Electronic Safety and Security.
11. B-6047 - Curtain Rod Specs.
12. B-5181 - Folding Shower Seat Specs.
13. SBADA-36-3F - ACORN Terrazzo-Ware Shower Base.
14. Drawing No.: A-603.2 - Door Schedule and Type.
15. Pavement Design Addendum Memorandum.
16. Flagpole Detail.
17. Pavement Design Report.
18. Limited Asbestos Survey.
19. Asbestos Survey.
20. Drilled Pier Reinforcement.
21. CaptiveAir Kitchen Hood Drawings.
22. COXREELS SH, MP, & HP Series Page.
23. Drawing No.: E-201.2 – Electrical Power Plan – Area A.
24. Proposed Sanitary Sewer Line Route.
25. Drawing No.: G-004.2 - Life Safety Plans.
26. Drawing No.: A-100.2 - Architectural Overall Floor Plan.
27. Drawing No.: A-110.2 - Architectural Overall Roof Plan.
28. Drawing No.: A-142.2 - Partial Furniture and Equipment Plan – Area B.
29. Drawing No.: A-201.2 - Exterior Elevations.
30. Drawing No.: A-202.2 - Exterior Elevations.
31. Drawing No.: A-203.2 - Exterior Elevations.
32. Drawing No.: A-300.2 - Building Sections.
33. Drawing No.: A-701.2 - 3D Views.
34. Drawing No.: A-702.2 - 3D Views.

SECTION 01210
CASH ALLOWANCES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. City's allowances allocated to the items of work listed or as directed.
- B. See Document 00700 - General Conditions, Paragraph 3.11 for costs included and excluded from cash allowance values listed in 1.02 below.
- C. Follow Section 01255 - Modification Procedures for processing allowance expenditures. Cash Allowance sums remaining at Final Completion belong to the City, creditable by Change Order.

1.02 SCHEDULE OF CASH ALLOWANCES (TOTAL \$875,000.00 VALUE)

- A. Allowance Item 1 - Building Permit: For obtaining the Building Permit from City of Houston, \$35,000.00.
- B. Allowance Item 2 - Permanent Electrical & Gas Service: For Center Point Energy work for \$300,000.00.
- C. Allowance Item 3 - Permanent Telephone Service: For Southwestern Bell Telephone work for, \$15,000.00.
- D. Allowance Item 4 – Equipment (FF&E): For Furniture Fixtures & Equipment (FF&E) work for, \$475,000.00.
- E. Allowance Item 5 – Moving Allowance: For HFD furniture and equipment relocation work for, \$50,000.00
- F. Allowance Item 6 – Building Signage & Graphics Allowance: For interior and exterior building signage & graphics work for, \$100,000.00

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

Document 00410A

BID FORM – PART A

To: **The Honorable Mayor and City Council of the City of Houston
City Hall Annex
900 Bagby Street
Houston, Texas 77002**

Project: IAH ARFF 81

Project No.: 669

Bidder:

(Print or type full name of business entity, such as corporation, LLC, etc)

1.0 OFFER

- A. Total Bid Price:** Having examined the Project location and all matters referred to in Bid Documents for the Project, we, the undersigned, offer to enter into a Contract to perform the Work for the Total Bid Price shown on the signature page of this Document
- B. Security Deposit:** Included with the Bid is a Security Deposit in the amount of 10 percent of the Total Bid Price subject to terms described in Document 00200 – Instructions to Bidders.
- C. Period for Bid Acceptance:** This offer is open to acceptance and is irrevocable for 180 days from Bid Date. That period may be extended by mutual written agreement of the City and Bidder.
- D. Addenda:** All Addenda have been received. Modifications to Bid Documents have been considered and all related costs are included in the Total Bid Price.
- E. Bid Supplements:** The following documents are attached:
 - Security Deposit (*as defined in Document 00200 – Instructions to Bidders*)
 - Document 00450 - Bidder's Statement of MWSBE Status
 - Document 00454 - Affidavit of Non-interest
 - Document 00455 - Ownership Information Form
 - Document 00456 - Bidder's Certificate of Compliance with Buy American Program (*required for AIP funded project*)
 - Document 00457 – Conflicts of Interest Questionnaire (CIQ)
 - Document 00458 - Bidder's Certificate Regarding Foreign Trade Restriction (*required for AIP funded project*)
 - Document 00459 - Contractor's Statement Regarding Previous Contracts Subject to EEO (*required for AIP funded project*)
 - Document 00460 – Pay or Play Acknowledgement Form (POP 1-A)
 - Document 00461 – Hire Houston First Affidavit
 - Document 00470 – Bidder's MWSBE Participation Plan (*required unless no MWSBE participation goal is provided in Document 00800 (the "Goal")*).
 - Document 00470D - Bidder's DBE Participation Plan (*required for AIP funded project*)

- Document 00471 – Bidder’s Record of Good Faith Efforts *(required if the goal in Bidder’s Participation Plan–Document 00470 is lower than the Goal).*
- Document 00472 – Bidder’s Goal Deviation Request *(required if the goal in Bidder’s Participation Plan–Document 00470 is lower than the Goal).*
- Document 00480 – Form SCM-1 Reference Verification
- Document 00481 – Non-Collusion Statement
- Document 00842 – Letter of Intent
- Others as listed: _____

2.0 CONTRACT TIME

- A. If offer is accepted, Contractor shall achieve Date of Substantial Completion within 865 days after Date of Commencement of the Work, subject to adjustments of Contract Time as provided in the Contract.

Document 00410B

BID FORM – PART B

1.0 TOTAL BID PRICE HAS BEEN CALCULATED BY BIDDER, USING THE FOLLOWING COMPONENT PRICES AND PROCESS (PRINT OR TYPE NUMERICAL AMOUNTS):

A. STIPULATED PRICE: \$ _____

(Total Bid Price; minus Base Unit Prices, Extra Unit Prices, Cash Allowances and All Alternates, if any)

B. BASE UNIT PRICE TABLE:

Item No.	Spec Ref.	Base Unit Short Title	Unit of Measure	Estimated Quantity	Unit Price (this column controls)	Total in figures
1	00800	Clean Air Incentive – N/A	Ea.			
2	00800	Contractor Bonus for Early Completion – N/A	Day			
<u>TOTAL BASE UNIT PRICES</u>						\$ _____

C. EXTRA UNIT PRICE TABLE:

Item No.	Spec Ref.	Extra Unit Short Title	Unit of Measure	Estimated Quantity	Unit Price (this column controls)	Total in figures
1		N/A				
<u>TOTAL EXTRA UNIT PRICES</u>						\$ _____

REST OF PAGE INTENTIONALLY LEFT BLANK

CASH ALLOWANCE TABLE:

Item No.	Spec Ref.	Cash Allowance Short Title	Cash Allowance in figures (1)
1		Building Permit	\$35,000.00
2		CenterPoint Electrical & Gas Allowance	\$300,000.00
3		Permanent Telephone & Cable Service	\$15,000.00
4		Furniture Fixtures & Equipment (FF&E)	\$475,000.00
5		Moving Allowance	\$50,000.00
6		Building Signage & Graphics Allowance	\$100,000.00
<u>TOTAL CASH ALLOWANCES</u>			\$975,000.00

REST OF PAGE INTENTIONALLY LEFT BLANK

E. ALTERNATES TABLE:

Item No.	Spec Ref.	Alternate Short Title	Unit of Measure	Estimated Quantity	Unit Price (this column controls)	Total Price for Alternate in figures
1		N/A				
<u>TOTAL ALTERNATES</u>						\$ _____

REST OF PAGE INTENTIONALLY LEFT BLANK

F. TOTAL BID PRICE:

\$ _____

(Add Totals for Stipulated Price, Base Unit Price, Extra Unit Price, Cash Allowance, and All Alternates, if any)

2.0 SIGNATURES: By signing this Document, I agree that I have received and reviewed all Addenda and considered all costs associated with the Addenda in calculating the Total Bid Price.

Bidder:

(Print or type full name of your proprietorship, partnership, corporation, or joint venture.*)

**By:

Signature Date

Name:

(Print or type name) Title

Address:

(Mailing)

(Street, if different)

Telephone and Fax Number:

(Print or type numbers)

- * If Bid is a joint venture, add additional Bid Form signature sheets for each member of the joint venture.
- ** Bidder certifies that the only person or parties interested in this offer as principals are those named above. Bidder has not directly or indirectly entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding.

Note: This document constitutes a government record, as defined by § 37.01 of the Texas Penal Code. Submission of a false government record is punishable as provided in § 37.10 of the Texas Penal Code.

SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Section 01 79 00 Demonstration and Training
- B. Section 23 08 00 Commissioning of HVAC Systems
- C. Section 26 08 00 Commissioning of Electrical Systems

1.2 SUMMARY

- A. The Commissioning Process (Cx) is a quality-focused process for enhancing the delivery of a project. Cx focuses on evaluating and documenting that all the commissioned systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's Project Requirements (OPR). For the purposes of this project, the OPR is defined as the HAS Design Standards, current version as of the date of this executed contract, and the programming deliverable provided by the AE consultant.
- B. Cx roles and responsibilities for each Project Delivery Team (PDT) member involved are defined in Sections 1.9 (Cx Team), 1.10 (Contractor) and 1.11 (CxA). Special responsibilities are included in the commissioning requirements section by division, where applicable.
- C. Cx does not dilute the responsibility of the designers or installing contractors to provide a finished and fully functioning product.
- D. Systems to be commissioned are listed in Section 1.5.

1.3 COORDINATION

- A. Commissioning Authority (CxA): the CxA is the individual that is responsible for the management of actions and generation of deliverables as outlined in the Cx Plan.
- B. Commissioning Provider (CxP): the CxP may comprise several companies, including subcontractors to the CxA who act as the contract to the Owner.
- C. Management: The CxA works for the Commissioning Manager (CxM)/Owner. The CxA directs and coordinates the project Cx Activities and reports the CxM/Owner and/or the Owner's Representative (O-REP). Team members work together to fulfill their contracted responsibilities and meet the objectives of the contract documents. The organization chart in Figure 1 clarifies the roles:

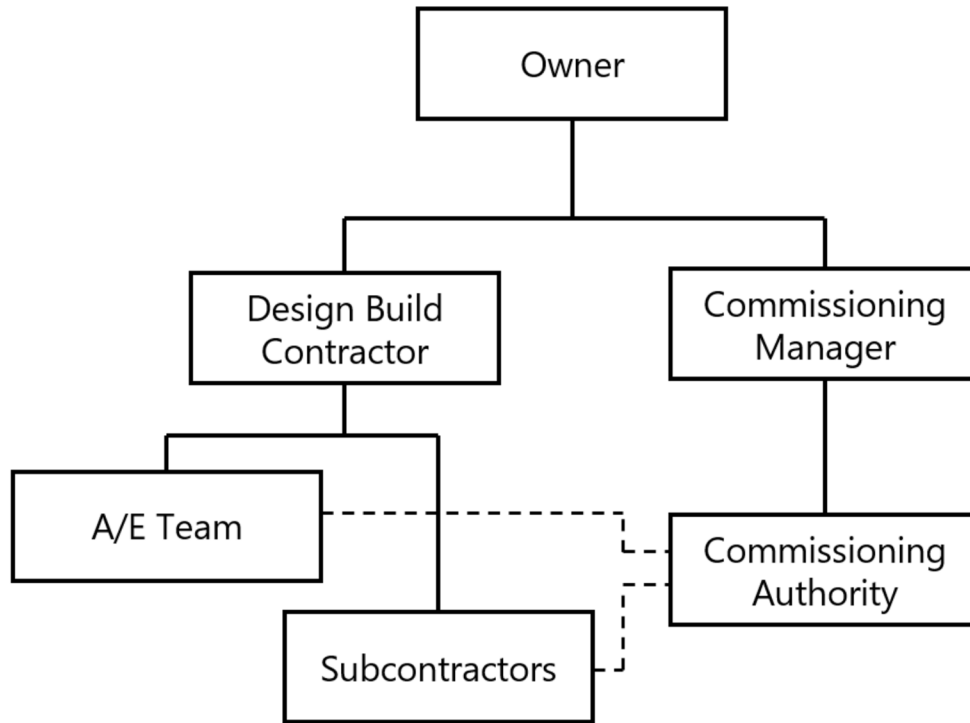


Figure 1. Organization Chart

1.4 COMMISSIONING PROCESS

- A. Cx activities shall begin in the design phase of the project but will initiate with the Cx Team that includes the Contractor during pre-construction with submittal reviews. The CxA shall distribute a Cx Plan that includes pre-functional and functional performance test procedures. As part of the startup procedures, the Contractor shall perform pre-functional testing and complete the web-based documentation in Facility Grid, or other designated system. The pre-verification testing will be completed by the Contractor(s) before functional performance testing begins, to ensure that ALL systems and equipment are ready for successful testing. The CxA shall witness the functional performance testing with the Contractor running each test and provide necessary support for completion of the procedures.

1.5 SYSTEMS TO BE COMMISSIONED

- A. Commission the following systems and assemblies:
1. Rooftop Package Units
 2. Air Valve Terminal Units
 3. Fan Powered Terminal Units
 4. Exhaust/Ventilation Fans

5. Building Automation System (BAS)
6. Lighting Control Systems
7. Primary Electrical Distribution

1.6 REFERENCES

- A. The publications listed below form a part of this specification to extent referenced.
 1. AMERICAN SOCIETY OF HEATING, REFRIGERATING, AND AIR-CONDITIONING ENGINEERS (ASHRAE)
 - a. ASHRAE Standard 202 (2018) Commissioning Process for Buildings and Systems
 - b. ASHRAE Guideline 1.1 (2007) HVAC&R Technical Requirements for the Commissioning Process, with errata published July 2, 2012
 2. INTERNATIONAL CODE COUNCIL
 - a. IECC – International Energy Conservation Code (2021)
 3. BUILDING COMMISSIONING ASSOCIATION
 - a. New Construction Commissioning, Best Practices (2018)
 4. ASTM INTERNATIONAL:
 - a. ANSI/ASTM E2947-21A (2021). Standard Guide for Building Enclosure Commissioning

1.7 DEFINITIONS

- A. OPR: Owner's Project Requirements. A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, supporting information, and operations and maintenance requirements.
- B. BoD: Basis of Design. A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- C. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- D. Test Checklists: CxA shall develop test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested.

- F. Certificate of Readiness: Certificate of Readiness shall be signed by the General Contractor, Subcontractor(s) certifying that systems, subsystems, equipment, and associated controls are ready for testing. Completed test checklists signed by the responsible parties shall accompany this certificate
- G. Test and Inspection Reporting: Subcontractors shall perform Pre-Functional Tests (provided by CxA), shall complete the Pre-Functional Test documentation (PFCs), and report all activities and progress in the cloud-based reporting tool (Facility Grid). Subcontractors shall perform Pre-Verification Testing based on Functional Test scripts provided by the CxA. The Subcontractors will then execute the Functional Performance Tests, which shall be witnessed by the CxA. The CxA shall complete the Functional Testing documentation, including observed issues, in Facility Grid.
- H. Corrective Action Documents: CxA shall document, in Facility Grid, ALL corrective action taken for systems and equipment that fail functional tests. Include required modifications to systems and equipment and revisions to test procedures, if any. Retest systems and equipment requiring corrective action and document retest results in Facility Grid.
- I. Commissioning Report: CxA shall document results of the commissioning process including unresolved issues and performance of systems, subsystems, and equipment. The commissioning report shall indicate whether systems, subsystems, and equipment have been completed and are performing according to the OPR, BOD, and Contract Documents.
- J. Commissioning Manager (CxM): The entity identified by the owner who ensures the commissioning process is executed by the CxA.
- K. Commissioning Authority (CxA): The entity identified by the owner who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process.
- L. General Contractor: The prime construction contractor, whether in a Bid/Build General Contractor role, a CMAR role, or a Design-Build prime role. The abbreviation GC shall denote any firm serving in the role of the construction prime contractor.
- M. Sub-Contractors: Contracted directly or indirectly to GC. Responsible for certain trade installations and related installation coordination with other trades.
- N. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.8 COMMISSIONING SOFTWARE FACILITY GRID

- A. The commissioning process relies upon tracking, documenting, and reporting of activities and milestones that have a critical impact on the project schedule. Communication between the Project Delivery Team members (Owner, CxM, Architect, Engineer, Constructor, Subs) is critical to recognizing potential issues in the commissioning process. This section addresses the use of commissioning software to facilitate tracking and reporting of the commissioning process.
 - 1. The CxA utilizes cloud-based software (Facility Grid) as a commissioning process management application reporting tool. As such, the CxA shall use Facility Grid to facilitate the Commissioning Process. Facility Grid will be used to manage Commissioning activities including but not limited to: Recording site observations, generating and completing PFCs and FPTs, tracking Commissioning issues and deficiencies, developing the Final Commissioning Report and the Systems Manual.
 - 2. The Facility Grid software license will be provided by the CxA at no cost to the project participants. The CxA will provide the training at no cost to the project participants as required for effective use of the software.
 - 3. The Contractors that have been awarded this project will be required to use Facility Grid for the purpose of completion of PFCs, PVTs, and for responding to Commissioning Issues.

1.9 COMMISSIONING TEAM

- A. Members appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of the General Contractor, Mechanical subcontractors, Electrical subcontractors, BAS subcontractors, suppliers, and specialists deemed appropriate by the CxA.
- B. Members appointed by Owner:
 - 1. CxM: The commissioning manager within the owner's organization, assigned to ensure successful completion of the commissioning process by the CxA.
 - 2. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
 - 3. Representatives of the facility user and operation and maintenance personnel.
 - 4. Architect and engineering design professionals.

1.10 CONTRACTOR'S RESPONSIBILITIES

- A. Provide utility services required for the commissioning process.
- B. Contractor shall assign representatives with expertise and authority to act on behalf of the Contractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:

1. Participate in construction phase coordination meetings.
 2. Participate in maintenance orientation and inspection.
 3. Develop and participate in operation and maintenance training sessions.
 4. Participate in final review at acceptance meeting.
 5. Furnish a copy of all construction documents, addenda, change orders, submittals and shop drawings related to commissioned equipment to the Cx Plan.
 6. Furnish a copy of documents required to compile the Facility Requirements and Operations and Maintenance Plan including but not limited to:
 - a. Sequences of operation for the building
 - b. Building occupancy schedule
 - c. Equipment run-time schedules
 - d. Setpoints for all HVAC equipment
 - e. Lighting levels throughout the building
 - f. Minimum outside air requirements
 - g. Changes in schedules or setpoints for different seasons, days of the week, and times of day
 - h. Systems narrative describing the mechanical and electrical systems and equipment
 - i. Preventive maintenance plan for building equipment described in the systems narrative
 7. Certify that Work is complete:
 - a. Provide completed manufacturer start-up documents.
 - b. Complete pre-functional checklists, issued by the CxA.
 - c. Complete pre-verification tests, issued by the CxA.
 - d. Include calibration of instrumentation and controls.
 - e. Provide required trend data for applicable systems.
 8. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
 9. Review and accept Cx test procedures provided by the CxA.
 10. Perform Cx test procedures, witnessed by the CxA.
 11. Perform opposite season testing, witnessed by the CxA.
 12. Attend warranty walk through with Cx Team at approximately 10 months from date of substantial completion, and address any deficiencies identified that are in-Contract by the AE or the CxA.
- C. Subcontractors shall assign representatives with expertise and authority to act on behalf of subcontractors and schedule them to participate in and perform Cx Team activities including, but not limited to, the following:
1. Participate in construction phase coordination meetings.
 2. Participate in maintenance orientation and inspection.
 3. Participate in procedures meeting for testing.
 4. Participate in final review at acceptance meeting.

5. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to CxA for incorporation into the Cx Plan. Update schedule throughout the construction period.
6. Provide information to the CxA for developing construction phase Cx Plan.
7. Participate in training sessions for Owner's operation and maintenance personnel.
8. Provide updated Project Record Documents to the CxA.
9. Gather and submit operation and maintenance data for systems, subsystems, and equipment to the CxA.
10. Provide technicians who are familiar with the construction and operation of installed systems and who shall participate in testing of installed systems, subsystems, and equipment.
11. Certify in writing that Work is complete and ready for Functional Testing:
 - a. Provide completed manufacturer start-up documents.
 - b. Complete pre-functional checklists, issued by the CxA.
 - c. Complete pre-verification tests, issued by the CxA.
 - d. Include calibration of instrumentation and controls.
 - e. Provide required trend data for applicable systems.

1.11 CxA'S RESPONSIBILITIES

- A. Develop the Cx Plan.
- B. Host Cx kickoff meeting.
- C. Review select project equipment submittals concurrently with the AE to confirm conformance with the OPR, or identify where deviations exist. Utilize information in approved submittals to complete development of the PFCs, PVTs, FPTs, and ISTs.
- D. Provide Project-specific construction checklists and Cx test procedures (PFCs, PVTs, FPTs, and ISTs).
- E. Conduct periodic site visits and report site observations to ensure the installation meets project requirements.
- F. Verify the execution of Cx activities at a random selection sampling rate described in the commissioning section of each applicable system specifications. The sampling rate may vary from 1 to 100 percent, as determined by the CxM. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, the CxA will report the failure in the Issues Log. The issues created under the random sampling protocol will apply as "typical" to all of the same equipment type.
- G. Prepare and maintain the Issues Log in Facility Grid.
- H. Prepare and maintain completed construction checklist log in Facility Grid.

- I. Witness systems, assemblies, equipment, and component startup in a manner that encourages the installing contractors to follow the project's quality assurance plan.
- J. Compile third party test data, BSG inspection reports, and certificates of readiness; include them in the systems manual and Cx Report.
- K. Witness seasonal testing and lead Cx Team in end of warranty walk through.

1.12 RE-TESTING

- A. Abort Functional Performance Tests, Integrated Systems Tests, or Seasonal Tests if any deficiency prevents successful completion of the test or if any required Cx Team member is not present for the test. Re-test only after all deficiencies identified during the original tests have been corrected. Re-testing will occur at the direction of the CxM and will be paid for with a deductive change order against the responsible party's contract. The decision to abort scheduled tests will be the responsibility of the CxA and the CxM.
- B. Systems or equipment, for which 100 percent sample size are tested, fail if one or more of the test procedures results in discovery of a deficiency during the test that prevents completion of the test. Re-test to the extent necessary to confirm that the deficiencies have been corrected without negatively impacting the performance of the rest of the system. Re-testing will occur at the direction of the CxM and will be paid for with a deductive change order against the responsible party's contract. The decision to fail scheduled tests will be the responsibility of the CxA.
- C. For systems tests with a sample size less than 100 percent, if one or more of the test procedures for an item of equipment or a system results in discovery of a deficiency, regardless of whether the deficiency is corrected during the sample tests, the item of equipment or system fails the test.
 - 1. If the system failure rate is 5 percent or less, meaning that 5 percent or less of the equipment or systems had at least one deficiency, re-test only on the items which experienced the initial failures.
 - 2. If the system failure rate is higher than 5 percent, meaning that more than 5 percent of equipment or systems tested had at least one deficiency, re-test the items which experienced the initial failures to the extent necessary to confirm that the deficiencies have been corrected. In addition, test another random sample of the same size as the initial sample for the first time. If the second random sample set has any failures, re-test those failed items and all remaining equipment and systems to complete 100 percent testing of that system type.
- D. If re-testing is required due to failed functional performance tests, the contractor is responsible for coordinating with necessary team members and adjusting the overall project schedule to accommodate the re-testing. The Contractor is also responsible for reimbursing any costs associated with factory representative and Cx Team members participation during re-retests. ~~Payment shall be made by contractor to Cx Team members prior to scheduling retesting site visits.~~

- E. If retesting is required, the contractor shall provide the CxA with 3 business days advanced notice for a test duration of less than 24 hours. For tests with duration of greater than 24 hours, advanced notice of 10 business days is required. The CxA shall not be held responsible for project delivery delays due to rescheduled tests to complete the Cx activities.

1.13 QUALITY ASSURANCE

- A. Instructor Qualifications: Factory-authorized service representatives experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.
 - 1. Test Equipment Calibration: Comply with test equipment manufacturer's calibration procedures and intervals. Provide current verification of calibration, in writing, prior to beginning and testing. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments. Instruments shall have been calibrated within six months prior to use.

1.14 COORDINATION

- A. Coordinating Meetings: The Contractor shall conduct the following coordination meetings with the Cx Team.
 - 1. Cx kick-off meeting.
 - 2. Submittal review meetings, as required.
 - 3. Construction progress meetings.
 - 4. BAS trends requirements meeting.
 - 5. Pre-test meetings.
 - 6. Cx issue resolution meetings, if determined necessary by the CxA.
 - 7. Any additional meetings deemed necessary to adequately perform Cx duties and functions.
- B. Testing Coordination: The Contractor shall coordinate, with the Cx Team, the schedule of functional performance testing, as identified in the Cx plan.
 - 1. Schedule times for tests, inspections, obtaining samples, and similar activities

PART 2 - PRODUCTS

2.1 MATERIALS

- A. The contractor provides their own respective tools, instruments, and consumables required to meet the requirements of the Cx as described in this section and related sections.

PART 3 - EXECUTION

- 3.1 Special execution of the Cx activities shall be defined in the technical commissioning specification for each applicable discipline.
- 1.
- 3.2 COMMISSIONING TESTS
- A. This subsection applies to Cx testing for all related divisions in ~~this section~~.
 - B. The contractor shall be responsible to fully execute testing of equipment, systems, and assemblies according to the specifications.
 - C. Pre-functional checklist will include requirements that Contractor:
 1. Provide BAS point to point report for each applicable system. The CxA requires this documentation be uploaded to Facility Grid.
 2. Pre-test all sequences of operation using the Pre-Verification Test on Facility Grid. The PVT is a version of the FPT completed by the Contractor.
 - D. Functional performance testing can only initiate after approval by CxA that the pre-functional checklists, pre-verification testing, and Test and Balance is complete. The Contractor shall provide the CxA with a minimum of 5 business days to review the PFCs, PVTs, and trend data, as well as a walk through onsite before scheduling the FPTs. The Contractor shall notify the CxA directly that the PFCs and PVTs are complete and trend data is ready for review by the CxA.
 - E. Test procedure format: A sample test form is provided in the Cx Plan. The test procedure forms developed by the CxA shall include, but not be limited to, the following information:
 - F. Problem solving: The burden of problem solving is on the Contractor, Engineer and the Architect, though the CxA may recommend solutions to problems found.
 - G. Functional performance test results: The CxA is responsible for determining the following results for each functional performance test they witness:
 1. Nonconformance
 2. Failure due to manufacturer defect
 3. Approval and acceptance
 - H. Deferred testing may be required by the CxA to address seasonal conditions that may prohibit a required test, or to accommodate changes in the project schedule. All such deferred testing requirements shall be coordinated with the Construction schedule and submitted for PDT and Cx Team review and acceptance.
 - 1.

3.3 TRAINING OF OWNER'S PERSONNEL

- A. The CxA shall confirm the owner's personnel receives adequate training, administered by the appropriate contractors or manufacturer representatives, in accordance with the training requirements set in these contract documents. The contractors shall submit a training matrix to the CxA that includes proposed dates, methods of training, systems or equipment to be covered, agenda of topics to be covered, and the trainer's qualifications. The contractor should also video record each training session, as required by the owner in the Owner's Project Requirements. The training matrix shall be provided to the CxA no later than 30 days prior to the proposed training dates. Upon completion of each training session, a copy of the video recording shall be provided to the CxA for confirmation of completion.

END OF SECTION

SECTION 01 91 15 BUILDING ENCLOSURE COMMISSIONING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Section 01 91 13 General Commissioning Requirements
- B. Section 01 91 17 Building Enclosure Functional Performance Testing
- C. Additionally, the following specification sections are related to the commissioning work specified in this section:
 - 1. Basic Concrete Requirements: Refer to Division 03
 - 2. Basic Masonry Requirements: Refer to Division 04
 - 3. Basic Waterproofing, Roofing, Air Barrier, Insulation Requirements: Refer to Division 07
 - 4. Basic Fenestration Systems Requirements: Refer to Division 08
 - 5. Basic Finishing Requirements: Refer to Division 09

1.2 SUMMARY

A. Section Includes:

- 1. The work under this section is subject to requirements of the Contract Documents, including the Owner's General Conditions and articles of the General Contractor's General Conditions.
- 2. This section includes the commissioning requirements for the Building Enclosure systems.
 - a. Refer to Section 019117 for Building Enclosure Functional Performance Testing.
 - b. The commissioning requirements for the building enclosure systems given in this section are in addition to, the General Commissioning Requirements specified in section 019113.
 - c. The General Contractor/Construction Manager, Contractors, Sub-contractors and Suppliers are required to participate in both commissioning processes as required by sections 019113 General Commissioning Requirements and 019115 Building Enclosure Commissioning.
 - d. The 019113 Commissioning Authority and 019115 Building Enclosure Commissioning Authority will coordinate to document each commissioning process. All documents will be tracked and stored in Facility Grid.

1.3 COORDINATION

- A. Building Enclosure Commissioning Team: Members of the Building Enclosure Commissioning Team (BECT) will consist of:

1. Architect and Engineers of Record (A/E)
 2. Building Enclosure Commissioning Authority (BECxA)
 3. Building Enclosure Testing Agency (BETA)
 4. Building Enclosure Subcontractors
 5. Commissioning Authority (CxA)
 6. Commissioning Provider (CxP)
 7. General Contractor (GC) or Construction Manager at Risk (CMAR). For the purposes of the BECT and the commissioning effort in general, the terms are interchangeable and mean the Construction Prime Contractor.
 8. Owner's Representative(s)
- B. Management: The CxA and BECxA will be the same entity, commonly known as the CxP. The BECxA will direct and coordinate commissioning activities through the CxA. All members of the Commissioning Team shall cooperate to fulfill contracted responsibilities and objectives of the Contract Documents.
- C. Scheduling: BECxA will work with the GC to establish required commissioning activities to incorporate in preliminary commissioning schedule. The GC will integrate commissioning activities into a master construction schedule. Necessary notifications are to be made in a timely manner in order to expedite the commissioning process.

1.4 BUILDING ENCLOSURE COMMISSIONING PROCESS

- A. Building Enclosure Commissioning is a systematic process of validating and verifying all building enclosure systems responsible for environmental separation perform interactively according to the Owner's Project Requirements as defined in the Contract Documents (drawings and specifications). The Building Enclosure Commissioning process is intended to achieve the following specific objectives according to the Contract Documents:
1. Verify and document installation and performance of building enclosure materials and systems.
 2. Endeavor to provide the Owner with functional Building Enclosure systems that meet the Project Requirements.
- B. Commissioning does not take away from, or reduce responsibility of, system designers or installing contractors to provide a finished and fully functioning product.
- C. This section shall in no way diminish the responsibility of Division 03, 04, 05, 07, 08, and 09 Contractors, Subcontractors, and Suppliers in performing all aspects of work and testing as outlined in the Contract Documents. Any requirements outlined in this section are in addition to or further define the requirements outlined in Division 03, 04, 05, 07, 08, and 09.

1.5 DEFINITIONS

- A. Approval: Acceptance that a material or system has been properly installed and is functioning in tested modes according to the Contract Documents.

- B. Architect/Engineer (A/E): Prime design consultant (architect) and sub-consultants who comprise the design team, generally the Architect of Record and any Design Sub-consultants.
- C. Basis of Design (BOD): Technical narrative of primary thought processes and assumptions behind design decisions made to meet design intent. Describes applications, systems, components, conditions, and methods chosen to meet the intent of the Owners Project Requirements.
- D. Building Enclosure Commissioning Authority (BECxA): Contracted to Owner through the CxA. BECxA directs and coordinates day-to-day Building Enclosure Commissioning activities in coordination with the CxA and the GC.
- E. Building Enclosure Commissioning Plan (BECx Plan): Overall plan developed after bidding that provides structure, schedule, and coordination planning for the Building Enclosure commissioning process.
- F. Building Enclosure Testing Agency (BETA): Contracted to the Owner. BETA is responsible for executing building enclosure functional performance testing under the direction of the A/E and BECxA.
- G. Building Enclosure Functional Performance Test (FPT): Test of performance of building enclosure materials and systems. Systems are tested under various simulated environmental conditions, such as air or water leakage under pressure differential. Refer to Section 01 9117.
- H. Commissioning Authority (CxA): Commissioning Authority for Building Systems; refer to Section 01 9113. Contracted to Owner. CxA directs and coordinates day-to-day Building Systems Commissioning activities, in coordination with the GC. CxA reports directly to Owner.
- I. Commissioning Provider (CxP): The CxP is the commissioning firm that provides the CxA and Cx technical specialists for the project.
- J. Commissioning Observation: Any condition identified by the BECxA that adversely affects the operability, maintainability or functionality of a system, or any equipment or component of a commissioned system. Any condition that conflicts with the project OPR, Contract Documents, contracted performance requirements, manufacturer requirements, and/or standard industry best practices of the installed systems and components will be documented and tracked. These observations will be posted in Site Observation Reports (SORs), and in the Facility Grid Issues Log, tracked until satisfactorily resolved.
- K. Owner's Project Requirements (OPR): A document developed by the Owner with input from their tenants and the design team that describes in both general and specific terms the requirements to be met in this project. Along with the contract documents, the OPR references the current HAS Design Standards. If conflict between the two exists, the more stringent requirement applies.

1.6 SUBMITTALS

- A. A/E or GC shall provide BECxA with the current set of contract documents. All building enclosure related submittals and shop drawings as required by the specifications shall be provided to the BECxA for review and comment, concurrent with the A/E team, for conformance as it relates to BECx, and so that the BECxA comments can be incorporated into the returned submittal along with the A/E's review comments.

- B. The contractor(s) shall review and address all exterior enclosure related submittal and shop drawing review comments. Revised shop drawing details based on submittal review comments shall be clearly marked on the shop drawing resubmittal to indicate where and what changes have been made. Submittal and shop drawing review comments and responses shall be tracked by the BECxA.
- C. The BECxA review of submittals and shop drawings does not substitute for or alter the responsibility of the A/E to review submittals and/or shop drawings for compliance with the project requirements. Final approval of submittals and shop drawings rests solely with the A/E.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 SYSTEMS TO BE COMMISSIONED

A. Building Enclosure Systems to be commissioned:

- 1. Below Grade Systems, Roofing Systems, Opaque Wall/Cladding Systems, Fenestration Systems responsible for providing the following functions:
 - a. Air control
 - b. Vapor control
 - c. Insulation/thermal protection
 - d. Waterproofing

3.02 RESPONSIBILITIES OF COMMISSIONING TEAM MEMBERS

A. Architect/Engineer (A/E)

- 1. Assist in the development and documentation of the Owner's Project Requirements document.
- 2. Provide brief Basis of Design summary to document the design intent of building enclosure systems to the BECxA.
- 3. Review and incorporate Building Enclosure Commissioning specification section and Building Enclosure Functional Performance Testing specification section into the construction documents.
- 4. Attend BECx design review meetings and other BECx meetings.
- 5. Provide construction documents electronically.
- 6. Review and respond to/incorporate BECxA comments made during design reviews and submittal/shop drawings reviews.
- 7. Assist in dispute resolution regarding building enclosure systems.
- 8. Utilize Facility Grid, a web-based commissioning management portal to access RFIs and

Issues generated by the BECxA. Facility Grid user licensing is provided at no cost to the BECT.

9. Review BECxA reports and respond to A/E items.
- B. Building Enclosure Commissioning Authority (BECxA)
1. Develop BECx plan.
 2. Development of the BECx Requirements and Building Enclosure FPT Requirements specification sections.
 3. Conduct reviews of the architectural drawings and specifications.
 4. Review pertinent building enclosure related submittals and shop drawings.
 5. Conduct BECx kick-off meetings.
 6. Perform construction observation visits to observe and document installation of the building enclosure materials, systems, and components, and observe representative field testing.
 7. Update the BECx plan as necessary.
 8. Prepare the final BECx report and related record documents.
 9. Perform one site visit at approximately 10 months post-occupancy.
- C. General Contractor (GC)
1. Attend BECx coordination/kick-off meetings and other commissioning team meetings. The GC is responsible for all coordination items with Subcontractors.
 2. Incorporate and periodically update commissioning activities into the construction schedule.
 3. Facilitate cooperation of Subcontractors in commissioning work.
 4. Review and respond to BECxA's submittal review comments.
 5. Utilize Facility Grid, a web-based commissioning management portal to access PFCs, FPTs and Issues generated by the BECxA. Facility Grid user licensing is provided at no cost to the BECT.
 6. Submit copies of initial submittals to A/E and BECxA for review. Provide final A/E approved submittals to BECxA for record.
 7. Verify building enclosure materials and assemblies are ready for functional performance testing. Coordinate scheduling of Building Enclosure FPT with the BECxA and BETA at least two weeks prior to testing.
 8. Ensure resolution of non-compliance and deficiencies in construction or test results. Provide written responses and documentation of completion from the appropriate subcontractors and record responses in Facility Grid.
 - 1) Documentation includes photographs of addressed items prior to concealment by other components.

9. Provide letters of compatibility for adjacent building enclosure materials and assemblies.
 10. Facilitate all repairs and retesting of failed functional performance testing and pay for all associated costs of retesting and additional testing including costs related to testing observation and documentation by the BECxA.
 11. Following failed field testing, provide a plan of repairs to be performed to the BECT for review. A/E shall approve plan of repairs prior to implementation and retesting. All repairs performed to facilitate successful testing must be approved by the A/E and performed comprehensively throughout project.
 12. Provide all warranty documentation for all commissioned building enclosure systems, materials, and components to the BECxA.
- D. Subcontractors/Vendors
1. Review Commissioning Plan and building enclosure related specification sections.
 2. Provide project-specific submittals/shop drawings as required by the project specifications that clearly indicate how each system is interfaced with adjacent systems. All typical and project-specific interfaces with adjacent systems must be detailed accurately.
 3. Attend BECx coordination/kick-off meetings and other commissioning team meetings.
 4. Address all applicable observations in Facility Grid, a web-based commissioning management portal to access RFIs and Issues generated by the BECxA. Facility Grid user licensing is provided at no cost to the BECT.
 - 5.
 6. Provide written responses and documentation of completion of addressed items as directed by GC.
 - 1) Documentation includes photographs of addressed items prior to concealment by other components.
 7. Attend all required building enclosure functional performance testing.
 8. Ensure installed work is complete, is in compliance with Contract Documents, and is ready for Functional Performance Testing. Notify GC that systems are ready for Functional Performance Testing.
 9. Provide all warranty documentation for all commissioned building enclosure systems, materials, and components to the GC.
- E. Building Enclosure Testing Agency (BETA)
1. Attend BECx coordination/kick-off meetings.
 2. Provide technicians and equipment to complete field Building Enclosure Functional Performance Testing.
 3. Prepare and submit reports at the conclusion of each test.
 4. Perform retesting and/or additional testing due to failed tests and prepare corresponding reports.

3.03 BUILDING ENCLOSURE COMMISSIONING (BECX) TEAM MEETINGS

- A. BECx meetings will be held periodically as determined by the BECxA.
- B. Discussions held in BECx meetings shall include, but not be limited to, system/materials, field progress, scheduling, testing, documentation, deficiencies, and problem resolution.

3.04 REPORTING

- A. The BECxA will provide monthly status reports to Owner, A/E, GC, and CxA.
- B. The BECxA shall submit non-compliance and deficiency reports Owner, A/E, GC, and CxA.
- C. The BECxA shall provide a final BECx Plan to serve as the BECx Record to Owner.

3.05 BUILDING ENCLOSURE FUNCTIONAL PERFORMANCE TESTING

3.06 Refer to Section 019117 - Building Enclosure Functional Performance Testing

3.07 DOCUMENTATION, NON-CONFORMANCE, AND RESOLUTION

A. Documentation

- 1. The BECxA shall submit observation reports Owner, A/E, GC, and CxA and log commissioning observations in Facility Grid.

B. Non-Conformance

- 1. Deficiency or non-conformance issues will be noted and reported to the GC, A/E, and Owner.
- 2. Corrections of minor deficiencies identified during site observations and testing may be documented by the BECxA.
- 3. Deficiencies are handled in the following manner:
 - a. When there is no dispute on deficiency and Subcontractor accepts responsibility for remedial action:
 - 1) BECxA documents deficiency and Subcontractor response and intentions via Facility Grid.
 - 2) Subcontractor corrects deficiency and provides response and/or documentation, in Facility Grid, that the deficiency has been addressed.
 - b. When there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
 - 1) BECxA documents deficiency and Contractor's response via Facility Grid.
 - 2) GC facilitates resolution of deficiency. Other parties are brought into discussions as needed. Final interpretive authority is with A/E. Final acceptance authority is with the Owner.

- 3) GC documents resolution process.
- 4) Once interpretation and resolution has been decided, appropriate party corrects deficiency and provides response and/or documentation, in Facility Grid, that the deficiency has been addressed.

3.08 COMMISSIONING DOCUMENTATION

A. Final Report Details

1. The final BECx report will include an executive summary, overview of BECx activities, and general description of testing and verification results. Report will contain a log of design review comments and responses, a log of submittal review comments and responses, and the issues log.
2. All outstanding non-compliance items will be specifically listed.
3. Recommendations for improvement to system or operations, future actions, etc. will also be listed.

END OF SECTION

SECTION 01 91 17 BUILDING ENCLOSURE FUNCTIONAL PERFORMANCE TESTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The work under this Section is subject to requirements of the Contract Documents including the Owner's General Conditions and articles of the General Contractor's/Design-Builder's General Conditions.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section. Division 3, 4, 7, 8, 9, and 32 Specification Sections also apply to this section. Where conflicts arise regarding building envelope testing, this Section shall supersede other Sections where contradictions occur.
- C. Refer to section 019113 for General Commissioning Requirements.
- D. Refer to section 019115 for the general Building Enclosure Commissioning Requirements.

PART 2 PRODUCTS

2.1 TESTING AGENCY

- A. The Building Enclosure Testing Agency (BETA) shall be an independent third-party with a minimum five (5) years of experience performing the testing as outlined in this specification section.
- B. The building enclosure functional performance testing scope of work is outside the building enclosure commissioning agent's (BECxA) scope of work. Building enclosure Functional Performance Testing (FPT) is performed by the BETA under the direction of the GC and BECxA
- C. The testing agency is to be contracted by the Owner. The testing agency shall be responsible for the specified testing outlined herein. The General Contractor is responsible for any costs associated with retesting and additional testing, including costs related to observation and documentation of retesting and additional testing by the BECxA.

PART 3 EXECUTION

3.1 MOCK-UP TEST REQUIREMENTS

- A. The mock-up should be constructed, tested, and accepted prior to commencement of installation of building envelope systems, assemblies, and components. Refer to Division 01, 03, 04, 07, 08 and 09 specifications and project-specific mock-up architectural drawings provided by the Architect/Engineer (A/E) for mock-up requirements, including testing.
- B. The coordination and completion of the mock-up construction should be completed by the GC. The GC shall permit observations of the mock-up to the Building Envelope Commissioning Agent (BECxA) and any member of the Building Envelope Commissioning Team throughout construction and testing as required.
- C. In the event of water leakage through the test sample either during pre-testing or final testing; additional isolation testing should be conducted to best determine the location of the water

infiltration as required.

- D. Following failed mock-up testing, GC to provide a plan of repairs to be performed to the BECT for review. A/E shall approve plan of repairs prior to implementation and retesting. All repairs performed to facilitate successful testing must be approved by the A/E and performed comprehensively throughout project.
- E. Retesting shall be conducted by the BETA. All costs associated with the repair and retesting shall be the responsibility of the contractor, including costs related to observation and documentation of retesting and additional testing by the BECxA.

3.2 FIELD TEST REQUIREMENTS

- A. Field functional performance testing should focus on interfaces and transitions of building enclosure systems, materials, and assemblies. All testing will be performed prior to the installation of interior insulation, gypsum wall board, interior (supplemental) sealant joints, and finishes. Specific test locations/specimens will be further developed and identified by the project team. Construction phase functional performance testing shall be performed in general locations identified as follows:

1. Air Barriers

- a. Air Leakage Volume Testing per ASTM E783 - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.
 - 1) Testing to be performed at no less than three (3) unique locations to include typical penetrations through the air barrier assembly including fasteners, sub-framing and service penetrations
- b. Air Barrier Adhesion Testing per ASTM D 4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
 - 1) Air-barrier assemblies will be tested for required adhesion to substrate according to ASTM D 4541 (with industry-accepted modifications for air barrier membranes) for each 1000 sq. ft. of installed air barrier or part thereof.
- c. Air barrier Thickness Testing per ASTM D6132 - Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Gage.
 - 1) Air-barrier assemblies will be tested for required thickness according to ASTM D6132 for each 100 sq. ft. of installed air barrier or part thereof.

2. Nozzle Water Penetration Tests

- a. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems.

- 1) Testing to be performed at 20 percent of the following locations within the glazed aluminum curtain wall assembly at approximately 10 percent, 35 percent and 70 percent of glazing completion.
 - a) Split mullion joints
 - b) Stack joints, where applicable
 - c) Intermediate horizontal joints
 - d) Head conditions at interface with other materials
 - e) Sill conditions at interface with other materials
 - f) Jamb conditions at interface with other materials
 - g) Expansion joints
 - 2) Testing to be performed at 20 percent of all horizontal and vertical panel joints of assembly and all jambs with adjacent materials at insulated metal panel locations,
 - 3) Testing to be performed at 20 percent of all joints within installed Fiberglass-Sandwich-Panel Assemblies
3. Air and Water Leakage Chamber Test
- a. *ASTM E783 – Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.*
 - b. *ASTM E1105 - Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls*
 - c. Testing shall be on an area 2 bays wide and 2 bays high at feature wall, clerestory, curtain wall and 2 bays wide by full height at window wall. Tests to be completed on installed units prior to completion of the first 5 percent of curtain wall installation Test locations will be selected to provide a representative sample of the project. Field testing shall be conducted at two-thirds of the designed water penetration resistance performance criteria.
 - d. Testing shall focus on assembly interfaces and transitions and will include the perimeter transition materials.
- B. Sealant Adhesion Testing
1. Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
 - b. Perform one test for each 1000 feet of joint length thereafter or one test per each floor per elevation.
 - c. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

- C. Electronic Leak Detection
 - 1. ASTM D7877 – Electronic Leak Detection Methods for Locating Leaks in Waterproofing Membranes
 - 2. Survey entire hot fluid-applied rubberized asphalt waterproofing and ketone ethylene ester (KEE) roofing areas for potential leaks using Electronic Leak Detection (ELD) before overlying construction is placed
 - 3. ASTM E 1186, Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems may be used to locate and diagnose potential leaks identified during ELD.

- D. Roof Infrared Thermography
 - 1. ASTM C1153 – Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging
 - 2. Prior to building turnover to Owner and before overlying construction is placed, survey single-ply insulated roof assemblies to identify potential areas of wet insulation.
 - 3. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection tests.
 - 4. Confirmation of wet roof insulation indicates deficient conditions that will require repair or reinstallation where required by specification 07 54 16 and ketone ethylene ester (KEE) roofing.

- E. All field functional performance testing shall be conducted to project performance requirements as set forth in the Construction Documents and below:

Performance Test	Test Specimen	Performance Criteria
Air Infiltration/exfiltration	Curtain wall	< 0.09 cfm/sf @ 6.24 psf
Air Infiltration/exfiltration	Air barrier	< 0.04 cfm/sf @ 1.57 psf
Water leakage	Curtain wall	No water leakage @ 10.00 psf
Water leakage	Opaque wall/cladding	No water leakage @ 10.00 psf
Air barrier adhesion	Air barrier, Sheathing	> 16 lbf/sq. in
Air barrier adhesion	Air barrier, CMU	> 30 lbf/sq. in
Sealant adhesion	Joint sealant	No adhesive failure
Electronic Leak Detection	KEE roofing	No potential leaks detected
Roof infrared thermography	KEE roofing	No areas of wet insulation
Coating Thickness	Air barrier, Traffic Coating	Mfg.'s minimum requirements

- F. The water leakage requirements are as follows:
 - 1. Water is contained and drained to the exterior
 - 2. There is no wetting of a surface that is visible to the building occupants
 - 3. There is no wetting or staining or other damage to completed building equipment, materials, or finishes

- G. The General Contractor shall notify the BETA and BECxA at least two weeks in advance of field test specimens being complete and ready for testing.

3.3 BETA REPORTING REQUIREMENTS

- A. Testing reports shall be provided by the BETA after field functional performance test.
- B. Reports shall include a description of the test method(s) and protocol used as well as all relevant testing parameters and pass/fail criteria. Any deviations from the referenced published testing standards or project documents shall be clearly identified and justification provided by the BETA.
- C. Reports shall identify specific testing locations and specimens and include photographs of the test specimens before, during, and after testing.
- D. Reports shall include testing results, including any relevant descriptions and photographs of testing failures.

3.4 TESTING FAILURES

- A. All failed testing areas are to be repaired and retested at CM's expense. Retesting shall be conducted by the BETA. All costs associated with the repair and retesting including all access, equipment, labor, and materials, as well as costs incurred by the BETA and BECxA site visits shall be the responsibility of the contractor.
- B. In addition to re-testing, failed tests may result in testing of additional specimens at locations selected by the BECxA at the cost of the contractor. Testing will be concluded only when satisfactory results are achieved. All failed test specimens shall be repaired and retested until passing results are achieved.
- C. Every effort will be made to expedite testing and minimize unnecessary delays, while not compromising integrity of tests. BECxA shall not overlook deficient work or loosen acceptance criteria to satisfy scheduling or cost issues unless directed to do so directly by the Owner.
- D. Where testing indicates that performance requirements are not met, the contractor shall provide a repair plan for review by the BECT. Once the plan of repairs is agreed upon, Subcontractor corrects deficiency and provides written response and/or documentation on the MIL that the deficiency has been addressed and verifies that material or assembly is ready to be retested. CM informs BECT of retesting schedule and reschedules retesting with BECxA and BETA. Testing and resolution process is repeated until satisfactory performance is achieved. CM shall maintain free and clear access to the test area until satisfactory performance is achieved.

END OF SECTION

SECTION 23 08 00 –COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 WORK OF THIS SECTION

- A. The Cx activities shall follow all requirements as defined in Section 01 91 13 GENERAL COMMISSIONING REQUIREMENTS.
- B. The section below describes unique Cx activities to the HVAC systems including the BAS. The Contractor shall follow all provisions of 01 9113 when meeting the requirements of this specification. Where conflicts may exist between the two specifications, the more restrictive requirement is to be met.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide all necessary test equipment to confirm proper operation of the Mechanical Systems.
- B. All testing equipment shall be properly calibrated, and documentation of such calibration shall be submitted prior to any verification testing.

PART 3 - EXECUTION

3.1 PARTICIPATION IN CX

- 1. The Prime Constructor shall coordinate and manage the completion of the Pre-Functional Checklists amongst the affected subcontractors, and shall coordinate and otherwise manage the Pre-Verification Testing of the Mechanical Systems under the supervision of the CxA.
 - 2. Packaged Rooftop Air-Conditioning Units
 - 3. Electric Unit Heaters
 - 4. Gas-Fired Infrared Heaters
 - 5. Exhaust/Ventilation Fan Systems
 - 6. Building Automation System (BAS)
 - 7. Gas-Fired Domestic Water Heaters and Circulating Pump
 - 8. Compressed Air Compressor
- B. Coordinate with the Division 26 and BAS subcontractors for performing and documenting pre-functional checks for each of the equipment items in the scope for Cx.

- C. Division 23 subcontractor and the BAS subcontractor are responsible for completing Point-to-Point testing, pre-functional testing, pre-verification testing and the execution of functional testing of the HVAC system in front of the CxA.
- D. Division 26 subcontractor and the BAS subcontractor are responsible for completing Point-to-Point testing, pre-functional testing, pre-verification testing and functional testing of electrical equipment and systems to the BAS.

3.2 DISTRIBUTION OF TREND DATA

- A. Trend data from the BAS will be utilized in the Cx activities. Contractor shall provide at least 1 full week of trend data to the Cx Team no later than 1 week before scheduling the functional performance testing. The Cx Team will analyze the trend data from the equipment and systems to be tested as part of the determination whether the testing can be scheduled.
- B. Trend data shall be recorded at intervals no greater than 15 minutes. Differential pressure transmitters shall be trended at a sampling rate of no less than every five minutes until the Functional Testing Period is complete and the installation is accepted by the CxA and the Owner. The trend data from each field controller shall be polled and stored in a central server location with capability of archiving the collected trend data for no less than 3 months of storage. The BAS shall be capable of automated distribution of the trend data configured for no less than weekly updates of the previous interval of data. Change of Value (COV) trending is not preferred and shall only be acceptable for status or binary command points.
- C. Trend data shall be saved in a non-proprietary format such as csv or txt with consistent organization of the data to include at a minimum the timestamp, BAS system trend name, value and units. The trend reports shall contain both tabular data and also represented in line graphs. With multiple points trended in each graph as requested by the CxA..
- D. Required trends by equipment type:
 - 1. Dx Rooftop Unit
 - a. Unit Mode of Operation
 - b. Discharge Air Temp
 - c. Space Temperature
 - d. Space Relative Humidity
 - 2. Exhaust/Ventilation Fan
 - a. Exhaust Fan Start/Stop
 - b. CO level at Truck Bays
 - 3. Heaters
 - a. Heaters Start/Stop

- b. Space Temperature
- 4. Water Heaters and Circulating Pump
 - a. Water Heaters Start/Stop
 - b. Circulating Pump Start/Stop
- 5. Compressor
 - a. Compressor Start/Stop

3.3 PRE-FUNCTIONAL AND FUNCTIONAL TEST FORMS

- A. After the initial equipment submittal phase, the CxA shall prepare the pre-functional test forms and the master functional performance tests for each type of equipment as part of the CxA's scope of work. Review respective pre-functional and functional test forms for accuracy and completeness within the review period defined by the CxA, and provide comments to the General Contractor and CxA.
- B. The following is a sample pre-functional test form:

CHK-67: AHU-1-1 (OAHU-TYPE1)

Test Type: **Pre-Functional Testing**

Asset Summary

Unit #	AHU-1-1		
Type	AIR HANDLING UNIT		
Discipline	HVAC		
Floor Name:	LEVEL 1	Floor Type:	Site
Room Name	MECH ROOM		

Equipment Verification

Equipment / Component	Approved Submittal Data	Installed As Submitted?	Installed Data
Manufacturer			
Model number			
Serial number			
Rated supply airflow (CFM)			
Rated outside airflow (CFM)			
Rated relief airflow (CFM)			
Rated exhaust airflow (CFM)			
Cooling capacity (MBH)			
Pre-heating capacity (MBH)			
Re-heating capacity (MBH)			
Humidifier capacity (MBH)			

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Equipment / Component	Approved Submittal Data	Installed As Submitted?	Installed Data
Heat wheel motor Volts/Ph/A and HP/effy			
Heat recovery pump motor Volts/Ph/A and HP/effy			
Supply fan motor Volts/Ph/A and HP/effy			
Relief fan motor Volts/Ph/A and HP/effy			
Exhaust fan motor Volts/Ph/A and HP/effy			
Outside air fan motor Volts/Ph/A and HP/effy			
Return fan motor Volts/Ph/A and HP/effy			

Questionnaire			
#	Question	Answer	Details
General Installation Checks			
1	Permanent labels affixed, per specifications	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor_____
2	Premium efficiency motors verified	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor_____
3	Casing condition good: no dents, leaks, door gaskets installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor_____
4	Access doors close tightly - no leaks	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor_____
5	Boot between duct and unit tight and in good condition	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor_____

#	Question	Answer	Details
6	Vibration isolation equipment installed and released from shipping locks	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
7	Maintenance access acceptable for unit and components	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
8	Thermal insulation properly installed and according to specification	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
9	Local instrumentation installed according to specification (thermometers, pressure gages, flow meters, etc.)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
10	Clean up of equipment completed per contract documents	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
11	Filters installed and replacement type and efficiency permanently affixed to housing	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
Fans and Dampers			
1	Fan and motor alignment verified	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
2	Fan belt tension and condition set	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
3	Fan protective shrouds for belts in place and secure	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
4	Fan area clean	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
5	Fan and motor properly lubricated	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
6	Fan and motor lube lines installed and lubed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____

#	Question	Answer	Details
7	Filters installed and replacement type and efficiency permanently affixed to housing--construction filters removed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
8	Filter pressure differential measuring device installed and functional (magnahelic, inclined manometer, etc.)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
9	Smoke and fire dampers installed properly per contract docs (proper location, access doors, appropriate ratings verified)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
10	All dampers close tightly	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
11	All damper linkages have minimum play	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
12	Low limit freeze stat sensor installed per manufacturer with adequate coverage	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Controls Contractor _____
Ducts (Preliminary Checks)			
1	Sound attenuators installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
2	Duct joint sealant properly installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
3	No apparent severe duct restrictions	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
4	Turning vanes installed per drawings	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
5	Pressure leakage tests completed, documentation provided to CxA	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____

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#	Question	Answer	Details
6	Balancing dampers installed per drawings and TAB's site visit	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 TAB Contractor _____
Electrical			
1	Pilot lights are functioning	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
2	Power disconnects in place and labeled	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Electrical Contractor _____
3	All electric connections tight	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Electrical Contractor _____
4	Proper grounding installed for components and unit	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Electrical Contractor _____
5	Safeties in place and operable	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
6	Current overload heaters installed and correct size	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
7	Appropriate Volts vs Hz curve is being used for speed signal	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Controls Contractor _____
Controls			
1	Sensors calibrated (refer to BAS calibration document)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Controls Contractor _____
2	All building control system interlocks connected with packaged controls and functional	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Controls Contractor _____
3	Fire and/or smoke detectors in place	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
4	Enthalpy control and sensor properly installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Controls Contractor _____

#	Question	Answer	Details
5	Related thermostats are installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Controls Contractor _____
6	Building automation system hardware installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Controls Contractor _____
7	All control devices wiring complete	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Controls Contractor _____
Supply Fan Motor			
1	No unusual noise or vibration in supply fan	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor _____
2	Record actual supply fan motor voltage: A-B	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
3	Record actual supply fan motor voltage: A-C	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
4	Record actual supply fan motor voltage: B-C	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
5	Calculate % supply fan motor voltage imbalance = $100 \times (\text{avg.} - \text{lowest}) / \text{avg.}$	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Electrical Contractor _____
6	Supply fan rotation is correct	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor _____
7	Supply fan motor service factor	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor _____
8	Supply fan motor running less than maximum amp rating?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor _____
9	Record supply fan motor actual amperage: T-1	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor _____
10	Record supply fan motor actual amperage: T-2	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Mechanical Contractor _____

#	Question	Answer	Details
11	Record supply fan motor actual amperage: T-3	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
Exhaust Fan Motor			
1	No unusual noise or vibration in exhaust fan	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
2	Record actual exhaust fan motor voltage: A-B	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Electrical Contractor _____
3	Record actual exhaust fan motor voltage: A-C	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Electrical Contractor _____
4	Record actual exhaust fan motor voltage: B-C	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Electrical Contractor _____
5	Calculate % exhaust fan motor voltage imbalance = $100 \times (\text{avg.} - \text{lowest}) / \text{avg.}$	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Electrical Contractor _____
6	Exhaust fan rotation is correct	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
7	Exhaust fan motor service factor	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
8	Exhaust fan motor running less than maximum amp rating?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
9	Record exhaust fan motor actual amperage: T-1	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
10	Record exhaust fan motor actual amperage: T-2	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
11	Record exhaust fan motor actual amperage: T-3	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Mechanical Contractor _____
TAB			

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#	Question	Answer	Details
1	Installation of system and balancing devices will allow balancing to be done per specified NEBB or AABC procedures and contract docs	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> TAB Contractor _____

Final Checks

1	All dampers stroke fully without binding and spans calibrated and BAS reading site verified	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Controls Contractor _____
2	Valves stroke fully and easily and spanning is calibrated	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Controls Contractor _____
3	Valves verified to not be leaking through coils when closed at normal operating pressure	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Controls Contractor _____
4	Safeties installed and safe operating ranges for this equipment provided to the commissioning agent	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Controls Contractor _____
5	Smoke and fire dampers are open	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
6	If unit is started and will be running during construction: have quality filters on RA grills, etc. to minimize dirt in the ductwork and coils and in any finished areas. Verify moisture migration is not a problem due to improper pressures between spaces.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____

END TEST

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#	Question	Answer	Details
1	Installation of system and balancing devices will allow balancing to be done per specified NEBB or AABC procedures and contract docs	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> TAB Contractor _____

Final Checks

1	All dampers stroke fully without binding and spans calibrated and BAS reading site verified	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Controls Contractor _____
2	Valves stroke fully and easily and spanning is calibrated	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Controls Contractor _____
3	Valves verified to not be leaking through coils when closed at normal operating pressure	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Controls Contractor _____
4	Safeties installed and safe operating ranges for this equipment provided to the commissioning agent	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Controls Contractor _____
5	Smoke and fire dampers are open	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____
6	If unit is started and will be running during construction: have quality filters on RA grills, etc. to minimize dirt in the ductwork and coils and in any finished areas. Verify moisture migration is not a problem due to improper pressures between spaces.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Mechanical Contractor _____

END TEST

3.4 FUNCTIONAL TEST FORMS

- A. After the final issue for record of the pre-functional test forms, the CxA shall prepare the functional test forms for each system to be documented as part of the Cx. Review respective functional test forms for accuracy and completeness and provide comments to the General Contractor and CxA.
- B. The following is a sample functional test form:

FPT-2: AHU-1-1 (AHU-1-1)

Test Type: **Functional Performance Testing**

Asset Summary

Unit #	AHU-1-1		
Type	Air Handling Unit		
Discipline	HVAC		
Floor Name:	LEVEL 1	Floor Type:	Site
Room Name	MECH ROOM		

System Description

TYPICAL OF - AHU-1-1, AHU-6-1, AHU-7-1, AHU-8-1, AHU-9-1, AHU-10-1, AHU-11-1, AHU-12-1

Sensor Calibration

Sensor & Location	Location OK?	First Gauge or BAS Value	Instrument Measured Value	Final Gauge or BAS Value	Pass
Supply Air Temperature					
Entering Water Temperature					

Questionnaire

#	Question	Answer	Details
OCCUPIED MODE			
1	ENABLE THE UNIT - DESCRIBE METHOD IN DETAIL	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	VERIFY THAT THE SUPPLY FAN IS RUNNING AND CONTROLLING TO THE STATIC PRESSURE SETPOINT (1.5in starting setpoint before reset)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	VERIFY THAT THE COMPRESSORS ARE STAGING TO MAINTAIN DISCHARGE AIR TEMP (55 DEG)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

#	Question	Answer	Details
UNOCCUPIED MODE			
1	ENABLE UNOCCUPIED MODE (ADJUST UNOCCUPIED SPACE COOLING SETPOINT - DEFAULT OF 85 DEG F)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
2	VERIFY SUPPLY FAN SHUT DOWN	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
3	VERIFY DX COOLING IS DISABLED	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
4	RELEASE SETPOINT AND RETURN UNIT TO DEFAULT SETPOINTS	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
DUCT STATIC PRESSURE CONTROL			
1	ENABLE UNIT AND VERIFY THAT DUCT STATIC PRESSURE SETPOINT IS AT ITS DEFAULT SETTING OF 1.5IN	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
2	DECREASE ZONE DAMPERS TO ALL BE AT 50% OPEN OR LESS - RECORD RESULTS (STATIC PRESSURE SETPOINT SHOULD DECREASE TO 1.3 IN OR BELOW)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
3	INCREASE ZONE DAMPERS TO BE AT 90% OR MORE - RECORD RESULTS IN DETAIL (STATIC PRESSURE SETPOINT SHOULD INCREASE TO 1.8 IN AS MAX SETPOINT)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
4	INITIATE HIGH SUPPLY STATIC PRESSURE ALARM (MANUALLY COMMAND FAN SPEED TO 25% HIGHER THAN STATIC PRESSURE SETPOINT) - RECORD RESULTS IN DETAILS	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
5	INITIATE LOW SUPPLY STATIC PRESSURE ALARM (MANUALLY COMMAND FAN SPEED TO 25% LOWER THAN STATIC PRESSURE SETPOINT) - RECORD RESULTS IN DETAILS	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
6	RELEASE SETPOINTS AND RETURN UNIT TO DEFAULT SETPOINTS	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
WATERSIDE ECONOMIZER			
1	ENABLE WATERSIDE ECONOMIZER (ENTERING WATER TEMP 4 DEG BELOW MAT) - RECORD STARTING DISCHARGE TEMP IN DETAILS	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
2	VERIFY THAT THE CONDENSING WATER VALVE OPENS AND RECORD THE DISCHARGE AIR TEMP IN DETAILS	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
3	DECREASE SUPPLY AIR SETPOINT SO ECONOMIZER MODE CANNOT SATISFY ALONE - CX COOLING SHOULD BEGIN STAGING (RECORD RESULTS IN DETAILS)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>

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#	Question	Answer	Details
ALARMS			
1	HIGH SUPPLY STATIC PRESSURE	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	LOW SUPPLY STATIC PRESSURE	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	SUPPLY FAN FAILURE	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	SUPPLY FAN IN HAND	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	DIRTY FILTER ALARM	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	HIGH SUPPLY AIR TEMP ALARM	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
7	DXCOOLING COMMAND ALARM	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

END TEST

SAMPLE

END OF SECTION

SECTION 23 09 23 - DIRECT-DIGITAL CONTROL SYSTEMS FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. A complete Direct Digital Control (DDC) system and instrumentation necessary to obtain all implied or intended functions and results specified herein. A complete system must include, but is not limited to, the following listed items: sensors, valves, dampers, valve and damper operators, DDC panels, power and control wiring, relays, terminal equipment controllers, mounting brackets, differential pressure wells, thermowells, operator's workstation(s), networks, and the like. The DDC control system shall connect back to the HAS network server per owner's requirements.
- B. The DDC control system shall consist of DDC and electric devices as specified. Provide all control devices of the type specified and/or required for each sequence, without exception.
- C. The control system shall consist of a high-speed, peer-to-peer network of DDC controllers, an operator workstation(s), and a web-based interface. The operator workstation shall allow operators to interface with the system via dynamic color graphics. It shall depict each mechanical system and building floor plan by a point and click graphic. Through the web-based interface, operators shall be able to access the system through a conventional web browser on each personal computer (PC) connected to the network.
- D. THE CONTROLS CONTRACTOR PROVIDING THE CONTROL SYSTEM UNDER THIS SPECIFICATION SHALL BE RESPONSIBLE, BOTH IN BIDDING AND IN CONSTRUCTION, FOR BRINGING ALL POWER TO HIS DEVICES TO INCLUDE BOTH LOW VOLTAGE AND LINE VOLTAGE POWER. THIS INCLUDES ALL CONTROL, INTERLOCK, AND POWER WIRING, CONDUIT, CIRCUIT BREAKERS, PANELBOARDS, AND TRANSFORMERS AS NECESSARY TO ACCOMPLISH ALL FUNCTIONS, SEQUENCES, AND INTERLOCKS SPECIFIED IN THIS SECTION. THIS REQUIREMENT CANNOT BE EXCLUDED BY THE CONTROLS CONTRACTOR DURING BIDDING. INFORMATION RELATING TO CONTROL SYSTEM DEVICE POWER IS NOT SHOWN ON THE ELECTRICAL DRAWINGS NOR IS IT THE RESPONSIBILITY OF THE ELECTRICAL CONTRACTOR. REFER TO ELECTRICAL SPECIFICATIONS FOR MATERIALS AND METHODS. ALL WIRING, REGARDLESS OF THE VOLTAGE, MUST BE RUN IN MINIMUM 1/2 INCH EMT CONDUIT. CLOSELY COORDINATE CONNECTIONS WITH ELECTRICAL CONTRACTOR.
- E. The entire DDC Control System must be provided by the System manufacturer. This shall include: Operator workstation software, controller software, custom application programming language, and controllers. All other products specified herein (e.g. dampers, sensors, valves, and actuators) need not be manufactured by the System manufacturer, but must provide seamless integration with the products of the System manufacturer.

- F. The system shall be capable of being monitored and controlled from a remote location and shall provide alarm notification via pager.
- G. Where specified herein or on the Drawings, the system shall interface with the following systems:
 - 1. Lighting control systems
 - 2. Fire alarm systems (All life safety systems required by code shall be integrated whether indicated on the Drawings or not).
 - 3. Occupant card access.
 - 4. Miscellaneous systems.

1.2 REFERENCES

- A. ANSI/ASHRAE 135 – Data Communication Protocol for Building Automation and Control Systems (BACNET).
- B. International Building Code.
- C. NEC – National Electric Code.
- D. UL 555S – Standard for Smoke Dampers

1.3 SUBMITTALS

- A. Complete Bill of Material, including manufacturer's certified rating data, description literature, catalog cuts, and shop drawings, for proposed:
 - 1. Control devices and equipment.
 - 2. Control dampers and valves.
 - 3. Control panels.
 - 4. Wiring materials and electrical power equipment.
- B. Include control, interlock, and power wiring diagrams and descriptions on operation of all control systems (sequences of operation) and their effect on other equipment and systems.
- C. Include an HVAC control schematic layout showing, in detail, the exact quantity of function points, printed circuit cards, the relationship of these elements and a description of how they interrelate operationally.
- D. Include a BACnet protocol Implementation Conformance Statement (PICS) for each type of controller and operator interface included in the submittal.
- E. Final submittal shall include operation and maintenance manuals.
- F. Provide and install, at no additional cost to owner, the latest firmware and software applicable for this project before the expiration of the warranty period.
- G. Combination Fire/Smoke Dampers and Smoke Dampers: Assign identification numbers for each damper with corresponding number noted on Drawings. Provide air quantity,

size, free area of damper, pressure drop and proposed velocity through each damper. Provide manufacturer's data of damper and its accessories or options. Provide power requirements

1.4 PROJECT RECORD DOCUMENTS

- A. Submit three copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of:
1. Project Record Drawings. As-built versions of submittal shop drawings provided as AutoCAD 2006 (or newer) compatible files on magnetic or optical disk (file format: .DWG or .DXF) and 6 prints of each drawing on 11" x 17" paper.
 2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of this specification.
 3. Operation and Maintenance (O&M) Manual. Printed, electronic, or online help documentation of the following:
 - a. As-built versions of submittal product data.
 - b. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
 - c. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
 - d. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
 - f. Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.
 - g. Graphic files, programs, and database on magnetic or optical media.
 - h. List of recommended spare parts with part numbers and suppliers.
 - i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 - j. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
 - k. Licenses, guarantees, and warranty documents for equipment and systems.
 - l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- B. Training Materials

1. Provide course outline and materials for each class at least six weeks before first class.
2. Training shall be furnished via instructor-led sessions, computer-based training, or web-based training.

1.5 QUALITY ASSURANCE

- A. System must be installed by a bonded company/contractor, certified and licensed by the system manufacturer to install systems within the local area, specializing exclusively in the design and installation of building management and control systems, located within a fifty mile radius of the project site, with a minimum of five years of documented experience installing DDC Control systems of equal or larger size and degree of difficulty (as determined by the Engineer).
- B. The equipment furnished under this section of the specifications must be supplied as a complete system, installed under the direct supervision and responsibility of the system manufacturer, and utilizing all of the various components specified to meet the functions and accuracies described within this section of the specifications.
- C. Perform, in conjunction with the Test and Balance (TAB) contractor, complete HVAC System and DDC Control System commissioning, to include verification of proper sequencing and operation of all DDC control system components. Refer to test and balance specification section(s) for additional requirements.
- D. This portion of the specifications sets a minimum standard of quality for all equipment and devices used in the control system and at the various control panels. Any reference to an equipment item, control system component, or panel is to apply equally to all similar items, system or panels as determined by the A/E.
- E. Provide all new, "first quality" grade hardware within this system. Select equipment on the basis of durability, serviceability and function. Provide only products that will be supported for at least the next five years.
- F. All equipment components, panels, and accessories shall be UL Listed under UL 916 (Energy Management Systems), UL 864-UUKL, UL 864-UDTZ (Signal Systems Unit) for use with Life Safety systems. All microprocessors shall comply with FCC Docket 20780 - Part 15, Subparagraph J.

1.6 WARRANTY

- A. Labor and Materials for the control system specified shall be warranted free from defects for a period of 12 months after final completion and acceptance.

1.7 OWNERSHIP OF PROPRIETARY MATERIALS

- A. All project-developed software and documentation shall become the property of the owner. These shall include, but are not limited to the following: Project graphic images, record drawings, project database, project-specific application programming code, and all documentation.

1.8 SYSTEM PERFORMANCE

- A. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer’s recommended hardware and software for operator workstation and server/browser.
1. Controllers: Controllers shall be able to execute DDC PID control loops at a selectable frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at the same frequency.
 2. Object Command: The maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analog objects should start to adjust within 2 seconds.
 3. Object Scan: All changes of state and change of analog values will be transmitted over the network such that any data used or displayed at a controller or workstation will have been current within the previous 6 seconds.
 4. Graphic Display: The system shall display a graphic with 20 dynamic points with all current data within 10 seconds.
 5. Graphic Refresh: The system shall update a graphic with 20 dynamic points with all current data within 8 seconds, and shall automatically refresh every 15 seconds.
 6. Multiple Alarm Annunciation: All workstations on the network must receive alarms within 5 seconds of each other.
 7. Alarm Response Time: The maximum time from when an object goes into alarm to when it is annunciated at the workstation(s) shall not exceed 15 seconds.
 8. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 seconds. The contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
 9. Configuration and Tuning Screens: Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 seconds.
 10. Reporting Accuracy: The system shall report all values with an end-to-end accuracy as listed or better than the following:

Measured Variable	Reported Accuracy
Space Temperature	+/- 1°F
Ducted Air Temperature	+/- 1°F
Outside Air Temperature	+/- 2°F
Dew Point Temperature	+/- 3°F
Water Temperature	+/- 1°F
Temperature Differential (Delta-T)	+/- 0.25°F
Relative Humidity	+/- 5% RH
Water Flow	+/- 2% of full scale
Airflow (Terminal Unit)	+/- 10% of full scale
Airflow (Measuring Station)	+/- 5% of full scale
Airflow (Pressurized Spaces)	+/- 3% of full scale
Air Pressure (Ducts)	+/- 0.1 in. w.g.
Air Pressure (Spaces)	+/- 0.01 in. w.g.
Water Pressure (Absolute)	+/- 2% of full scale
Water Pressure (Differential)	+/- 2% of full scale

Electrical (A,V,W, Power Factor)	+/- 5% of reading
Carbon Monoxide (CO)	+/- 5% of reading
Carbon Dioxide (CO ₂)	+/- 50 ppm

11. Stability of Control: Control loops shall maintain measured variable at setpoint within the tolerances listed below:

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	+/- 0.2 in. w.g. +/- 0.01 in w.g.	0 – 6 in w.g. -0.1 – 0.1 in. w.g.
Airflow	+/- 10% of full scale	
Space Temperature	+/- 1°F	
Duct Temperature	+/- 2°F	
Humidity	+/- 3% RH	
Fluid Pressure	+/- 1.5 psi +/- 1.0 in. w.g.	1 – 150 psi 0 – 50 in. w.g. differential

1.9 COORDINATION WITH OTHER TRADES

- A. This controls contractor shall work closely with other trades to ensure all work is completed so as to provide a fully functional and operating system in accordance with the contract documents and Owner’s expectations. This does not in any way relieve the prime contractor from the overall responsibility to ensure that all work is coordinated and that all of it’s subcontractors are aware of their responsibilities.
- B. The following products shall be furnished by this Section but installed under a separate Section of these specifications. The specification section reference in parentheses indicates the section responsible for installation.
1. Control Valves (Hydronic Piping).
 2. Solenoid Gas Shut-Off Valves (Natural Gas Piping) – Controls contractor shall also furnish and install EPO switch as specified or as shown on the Drawings.
 3. Flowmeters (Hydronic Piping).
 4. Flow Sensors/Switches/Meters (Hydronic Piping).
 5. Pressure and Temperature wells and sockets (Hydronic Piping).
 6. Temperature sensor wells and sockets (Hydronic Piping).
 7. Airflow measuring stations (Ductwork Accessories).
 8. Automated Dampers (Ductwork Accessories).
 9. Smoke Dampers and Combination Fire/Smoke Dampers (Ductwork Accessories) – Integrated with Fire Alarm System. Power to these provided by controls contractor.
 10. Terminal Unit Controls (Air Terminal Units) – Controls contractor shall furnish controls to terminal unit vendor for factory installation.
- C. The following products shall be installed by this Section but furnished under a separate Section of these specifications. The specification section reference in parentheses indicates the section responsible for furnishing.
1. Refrigerant Leak Detection System (Chillers).
 2. Duct Static Pressure Sensors (Ductwork Accessories).
 3. Duct Detectors (Fire Alarm).

- D. The following products are not furnished or installed by this section but shall be integrated with the work of this section.
1. Boiler controls: The boiler vendor shall furnish boilers with an interface to the control and monitoring points specified in the Project. These specified points shall be the minimum acceptable interface to the boiler. The connection to these points shall be by one of the following methods: (a) Hardwired connection such as relay, 0-10VDC, or 4-20mA. (b) BACnet/IP network connection. (c) BACnet over ARCNET network connection. (d) BACnet MS/TP network connection.
 2. Chiller controls: The chiller vendor shall furnish chillers with an interface to the control and monitoring points specified in the Project. These specified points shall be the minimum acceptable interface to the chiller. The connection to these points shall be by one of the following methods:(a) Hardwired connection such as relay, 0-10VDC, or 4-20mA. (b) BACnet/IP network connection. (c) BACnet over ARCNET network connection. (d) BACnet MS/TP network connection.
 3. Packaged AHU or evaporative cooler controls: Unit shall be furnished configured to accept control inputs from an external building automation system controller as specified in the Project. Factory mounted safeties and other controls shall not interfere with this controller.
 4. Terminal units: Terminal Units shall be furnished configured to accept control inputs from an external building automation system controller as specified in the project. Factory mounted safeties and other controls shall not interfere with this controller. Note: Terminal unit controllers shall be furnished under this section and provided to the terminal unit vendor for installation on the terminal unit.
 5. Variable frequency drives: The variable frequency drive (VFD) vendor shall furnish VFDs with an interface to the control and monitoring points specified in the project. These specified points shall be the minimum acceptable interface to the VFD. The connection to these points shall be by one of the following methods: (a) Hardwired connection such as relay, 0-10VDC, or 4-20mA. (b) BACnet/IP network connection. (c) BACnet over ARCNET network connection. (d) BACnet MS/TP network connection.
 6. Fire Alarm Systems: Where HVAC control functions are indicated or required to be integrated with fire alarm system the devices shall be furnished with a BACnet interface for integration into the Direct Digital Control System described in this section.
 7. Communications with third-party equipment: Any additional integral control systems included with the products integrated with the work of this section shall be furnished with a BACnet interface for integration into the Direct Digital Control System described in this section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The following control system manufacturers shall be deemed as acceptable manufacturers provided the submitted products meet the requirements of this Specification.
1. Automated Logic.
 2. Johnson Controls, Inc.
 3. Siemens Building Technologies, Inc.

4. Alerton.

2.2 COMMUNICATION

- A. All control products provided for this project shall comprise a BACnet internetwork. Communication involving control components (all types of controllers and operator interfaces) shall conform to ANSI/ASHRAE Standard 135-2004, BACnet.
- B. Install new wiring and network devices as required to provide a complete and workable control network. Where Drawings or other areas of the Specification indicate remote buildings or sites, these remote buildings or sites shall be connected by a nominal 56K baud modem over voice-grade telephone lines. In each remote location a modem and field device connection shall allow communication with each controller on the internetwork.
- C. Internetwork
 - 1. High-Speed Ethernet (ISO 8802-3 Data Link/Physical layer protocol).
 - 2. Break in Communication Path: Alarm and automatically initiate network reconfiguration.
 - 3. Transmission Media: Fiber optic or single pair of solid 24 gage twisted, shielded copper cable.
 - 4. Network Support: Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention
- D. Each BACnet device shall operate on the BACnet Data Link/Physical layer protocol specified for that device.
- E. All controllers shall have a communication port for connections with the operator interfaces using the BACnet Data Link/ Physical layer protocol.
- F. Communication services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:
 - 1. Connection of an operator interface device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the network.
 - 2. All database values of any one controller shall be readable by any other controller on the internetwork, without any additional communication services.
- G. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.
- H. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

- I. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards specified by the Web Services Interoperability Organization (WS-I) Basic Profile 1.0 or higher. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the system.
 1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
 2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
 3. For read or write requests, the system shall require user name and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.
 4. System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow a third party Web services device to read data from or write data to any object in the system which supports this service.

2.3 OPERATOR INTERFACE

- A. Furnish a web server and One(1) PC-based computer workstation able to access all information on the system. The server and workstation(s) shall reside on the same high-speed network as the controllers.
- B. In addition to the primary operator interface, the system shall include a secondary interface compatible with a locally available commercial wireless network and viewable on a commercially available wireless device such as a Wireless Access Protocol (WAP) enabled cellular telephone or personal digital assistant (PDA). This secondary interface may be text-based and shall provide a summary of the most important data. As a minimum, the following capabilities shall be provided through this interface.
 1. An operator authentication system that requires an operator to log in before viewing or editing any data, and which can be configured to limit the privileges of an individual operator.
 2. The ability to view and acknowledge any alarm in the system. Alarms or links to alarms shall be provided on a contiguous list so the operator can quickly view all alarms.
 3. A summary page or pages for each piece of equipment in the system. This page shall include the current values of all critical I/O points and shall allow the operator to lock binary points on or off and to lock analog points to any value within their range.
 4. Navigation links that allow the operator to quickly navigate from the home screen to any piece of equipment in the system, and then return to the home screen. These links may be arranged in a hierarchical fashion, such as navigating from the home screen to a particular building, then to a specific floor in the building, and then to a specific room or piece of equipment.

- C. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135-2004, BACnet Annex J.
- D. Web Server / Workstation Hardware:
1. Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified herein. Hard disk shall have sufficient memory to store system software, one year of data for trended points specified herein, a system database at least twice the size of the existing database at system acceptance, and shall meet minimum size indicated below.
 2. Web server and workstations shall be IBM-compatible PCs with a minimum of:
 - a. Intel Pentium 3.0 GHz processor.
 - b. 2 GB RAM.
 - c. 80 GB hard disk providing data at 100 MB/sec.
 - d. 48x CD-ROM drive.
 - e. Keyboard: Low profile, detachable, having standard "qwerty" layout plus a 10 key numeric keypad, and dedicated function keys.
 - f. Mouse: Software supported mouse with support software including self-building menus and displays of system operations and functions.
 - g. 17-inch 24-bit color flat panel monitor with at least 1024 x 768 resolution.
 - h. Serial, parallel, and network communication ports and cables required for proper system operation.
 3. Printer: Hewlett Packard 2400 Laserjet or Engineer Approved Equal.
 4. Modem: Auto-dial modem and associated cables shall transmit over voice-grade telephone lines at a nominal 56,000 baud and shall provide communication between workstation or web server and remote buildings and workstations.
- E. Operator interface shall allow each authorized operator to execute the following functions as a minimum:
1. Log In and Log Out: System shall require user name and password to log in to operator interface.
 2. Point-and-click Navigation: Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
 3. View and Adjust Equipment Properties: Operators shall be able to view controlled equipment status and to adjust operating parameters such as setpoints, PID gains, on and off controls, and sensor calibration.
 4. View and Adjust Operating Schedules: Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.
 5. View and Respond to Alarms: Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms.

6. View and Configure Trends: Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.
7. View and Configure Reports: Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.
8. Manage Control System Hardware: Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.
9. Manage Operator Access: Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.

2.4 OPERATIONS SOFTWARE

A. System Software

1. Web server or workstation shall have an industry-standard professional-grade operating system. Acceptable system shall be Microsoft Windows XP Pro.
2. Operator interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.
 - a. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
 - b. Graphics shall be able to animate by displaying different image files for changed object status.
 - c. Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - d. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).

B. System Tools

1. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation and web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.

2. Automatic System Database Configuration: Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
3. Controller Memory Download: Operators shall be able to download memory from the system database to each controller.
4. System Configuration: Operators shall be able to configure the system.
5. Online Help: Context-sensitive online help for each tool shall assist operators in operating and editing the system.
6. Security. System shall require a user name and password to view, edit, add, or delete data.
 - a. Operator Access: Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object. Authorized operators shall be able to vary and deny each operator's accessible functions based on equipment or geographic location.
 - b. Automatic Log Out: Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.
 - c. Encrypted Security Data: Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
7. System Diagnostics: System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).
8. Alarm Processing: System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified herein. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
9. Alarm Messages: Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.
10. Alarm Reactions: Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
11. Alarm Maintenance: Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server hard disk from each workstation or web browser interface.
12. Trend Configuration: Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified herein. Trends shall be BACnet trend objects.
13. Object and Property Status and Control: Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics, or through custom programs.

14. Reports and Logs: Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
15. Standard Reports: Furnish the following standard system reports:
 - a. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
 - b. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
 - c. System shall log the following to a database or text file and shall retain data for an adjustable period.
 - 1) Alarm History.
 - 2) Operator shall be able to select trends to be logged.
 - 3) At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.
16. Custom Reports: Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface.
17. Graphics Generation: Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.
18. Graphics Library: Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.
19. Custom Application Programming: Operator shall be able to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
 - a. Language shall be graphically based and shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks.
 - b. Tool shall provide a full-screen, cursor-and-mouse-driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify, and delete custom programming code, and to copy blocks of code to a file library for reuse in other control programs.
 - c. Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.
 - d. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays,

- integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.
- e. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - f. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.
 - g. Operator shall be able to use variable values in program conditional statements and mathematical functions.
 - 1) Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.
 - 2) Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.
- C. Portable Operator's Terminal: Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.
- D. Web server or workstation shall have demonstrated interoperability during at least one BMA Interoperability Workshop and shall substantially conform to BACnet Operator Workstation (B-OWS) device profile as specified in ASHRAE/ANSI 135-2001, BACnet Annex L.

2.5 CONTROLLER SOFTWARE

- A. Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.
- B. System shall provide the following schedule options as a minimum:
 - 1. Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 - 2. Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
 - 3. Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.
- C. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.

- D. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
- E. Programming Application Features:
 - 1. Demand Limiting:
 - a. System shall monitor building power consumption from building power meter pulse generator signals or from building feeder line watt transducer or current transformer.
 - b. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand. When demand drops below adjustable levels, system shall restore loads as specified.
 - 2. Maintenance Management: System shall generate maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified herein.
 - 3. Sequencing: Application software shall sequence chillers, boilers, and pumps as specified herein.
 - 4. PID Control: System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.
 - 5. Staggered Start: System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
 - 6. Energy Calculations:
 - a. System shall accumulate and convert instantaneous power (kW) or flow rates (gpm) to energy usage data.
 - b. System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.
 - 7. Anti-Short Cycling: Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
 - 8. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.
 - 9. Runtime Totalization: System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified herein.

2.6 CONTROLLERS

- A. Provide Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified herein. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.

- B. Controller hardware shall be suitable for anticipated ambient conditions.
 - 1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -20°F to 140°F.
 - 2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 32°F to 120°F.
- C. Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.
- D. Controllers that perform scheduling shall have a real-time clock.
- E. Serviceability:
 - 1. Controllers shall have diagnostic LEDs for power, communication, and processor.
 - 2. Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
 - 3. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
- F. Memory
 - 1. Controller memory shall support operating system, database, and programming requirements.
 - 2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
 - 3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
- G. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft.
- H. Transformer: ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.
- I. BACnet Protocols:
 - 1. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
 - 2. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
 - 3. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

4. Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
5. Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
6. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.

J. Communication

1. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
2. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
3. Each BC and AAC shall share data as required with each networked BC and AAC.
4. Each piece of equipment specified herein shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

2.7 INPUT AND OUTPUT INTERFACE

- A. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.
- B. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.
- C. Inputs
 1. Binary Inputs: Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.
 2. Pulse Accumulation Inputs: Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.
 3. Analog Inputs: Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- D. Outputs
 1. Binary Outputs: Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
 2. Analog Outputs: Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually

adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.

3. Tri-State Outputs: Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.

- E. Universal Inputs and Outputs: Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

2.8 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies

1. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
2. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes.
3. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
 - a. Unit shall operate between 32°F and 120°F.
 - b. EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
 - c. Line voltage units shall be UL recognized and CSA listed.

B. Power Line Filtering: Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have.

1. Dielectric strength of 1000 V minimum.
2. Response time of 10 nanoseconds or less.
3. Transverse mode noise attenuation of 65 dB or greater.
4. Common mode noise attenuation of 150 dB or greater at 40-100 Hz.

2.9 AUXILIARY CONTROL DEVICES

A. Motorized Control Dampers

1. Control dampers shall have linear flow characteristics and shall be parallel- or opposed-blade type as specified below or as scheduled on drawings.
 - a. Outdoor air dampers shall be opposed blade.
 - b. Return air mixing dampers and face-and-bypass dampers shall be parallel-blade and shall direct airstreams toward each other.
 - c. Other modulating dampers shall be opposed-blade.
 - d. Two-position shutoff dampers shall be parallel- or opposed-blade with blade and side seals.

2. Damper frames shall be 13 gauge galvanized steel channel or 1/8 in. extruded aluminum with reinforced corner bracing.
 3. Damper blades shall not exceed 8 in. in width or 48 in. in length. Blades shall be suitable for medium velocity 2000 fpm performance. Blades shall be not less than 16 gauge.
 4. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better
 5. Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than 10 cfm per ft² at 4 in. w.g. differential pressure. Blades shall be airfoil type suitable for wide-open face velocity of 1500 fpm.
 6. Damper sections shall not exceed 48 in. Each section shall have at least one damper actuator.
 7. Linkages. Dampers shall have exposed linkages.
 8. Any automated damper used as part of a smoke control system shall be considered a smoke damper and listed for the application.
- B. Electric Damper and Valve Actuators
1. Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.
 2. Spring-return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).
 3. Signal and Range. Proportional actuators shall accept a 0-10 Vdc or a 0-20 mA control signal and shall have a 2-10 Vdc or 4-20 mA operating range. (Floating motor actuators may be substituted for proportional actuators in terminal unit applications as described above).
 4. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.
 5. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 60 in.-lb torque capacity shall have a manual crank.
- C. Solenoid Gas Shut-Off Valves
1. Direct Acting, aluminum body, with stainless steel core tube. Valve shall be normally-closed operation for air or vacuum service. Provide valve UL listed for the application. Enclosure shall be suitable for operating environment. A push button EPO switch shall be furnished and installed along with the valve. Coordinate location of push button with Architect/Engineer prior to installation.
 2. Operation of the entire system shall be tested and verified by this contractor.
 3. Refer to plumbing drawings and/or control drawings for valve locations and sizes.
 4. Voltage shall be as required unless otherwise indicated.
 5. Acceptable Manufacturers: Asco Valve, Inc.
- D. Smoke Dampers
1. Each smoke damper shall be dynamic rated type and shall be further classified under the latest version of UL 555S, and bear a UL label attesting to same. Leakage rating under UL 555S shall be no higher than Leakage Class II (4 CFM per square foot at one-inch water gauge pressure and 8 CFM per square foot at 4

inches water gauge pressure). Smoke dampers and their operators shall be qualified under UL 555S to an elevated temperature of 350 degrees F. Maximum air pressure drop through each smoke damper shall not exceed 0.10-inch water gauge at the design air quantity. (Note that this may require a larger damper than the connected duct size.) All ratings shall be dynamic.

2. Motors for operation of smoke dampers shall be smoke system fail safe, spring return normally open supplies and normally closed returns, or as indicated on the Drawings, and shall be furnished and installed by the damper manufacturer as required by the UL rating mentioned above. Motors shall be electric or pneumatic to match the type of temperature control system specified elsewhere in this Specification. All required relays, EP switches, wiring piping and other labor and material necessary to completely interconnect the smoke detector system shall be furnished by the Contractor.

E. Combination Fire/Smoke Dampers

1. Each combination fire/smoke damper shall be 1-1/2 hour fire rated under UL Standard 555, and shall be further classified by UL as a Leakage Rated Damper for use in smoke control systems under the latest version of UL 555S, and bear a UL label attesting to same. The leakage rating under UL 555S shall be no higher than Leakage Class II (4 CFM per square foot at one-inch water gauge pressure and 8 CFM per square foot at 4 inches water gauge pressure). Combination fire/smoke dampers and their operators shall be qualified under UL 555S to an elevated temperature of 350 degrees F. Maximum air pressure drop through each combination fire/smoke damper shall not exceed 0.10-inch water gauge at the design air quantity. (Note that this may require a larger damper than the connected duct size.) All ratings shall be dynamic.
2. Motors for operation of combination fire/smoke dampers shall be smoke system fail safe, spring return normally open supplies and normally closed returns, or as indicated on the Drawings, and shall be furnished and installed by the damper manufacturer as required by the UL rating mentioned above. Motors shall be electric or pneumatic to match the type of temperature control system specified elsewhere in this Specification. All required relays, EP switches, wiring piping and other labor and material necessary to completely interconnect the smoke detector system shall be furnished by the Contractor

F. Control Valves

1. Select body and trim materials in accordance with manufacturer's recommendations for design conditions and service shown.
2. Characterized Control Valves (CCV) shall be used for all water applications requiring equal percentage characteristics. Globe valves may be used only if CCV's do not fit the sizing criteria or application. Butterfly valves shall be used for control valves 4-inches and larger.
3. Provide two- or three-way control valves for two-position or modulating service as shown.
4. Water Valves:
 - a. Valves providing two-position service shall be quick opening.
 - b. Valve actuator and trim shall provide the following minimum close-off pressure ratings.
 - 1) Two-way: 150% of total system (pump) head.

- 2) Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
 - c. Valves providing modulating service shall have equal percentage ports.
 - d. Sizing:
 - 1) Two-position service: line size.
 - 2) Two-way modulating service: select pressure drop equal to the greatest of twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 5 psi.
 - 3) Three-way modulating service: select pressure drop equal to the smaller of twice the pressure drop through the coil exchanger (load) or 5 psi.
 - e. Water valves shall fail normally open or closed as follows unless otherwise specified:
 - 1) Water zone valves: normally open.
 - 2) Heating coils in air handlers: normally closed.
 - 3) Chilled water control valves: normally open.
 - 4) Other applications: as scheduled or as required by sequences of operation.
- 5. Steam Valves
 - a. Valve actuator and trim shall provide minimum close-off pressure rating equal to 150% of operating (inlet) pressure.
 - b. Valves providing modulating service shall have linear ports.
 - c. Sizing
 - 1) Two-position service: select pressure drop equal to 10%-20% of inlet psig.
 - 2) Modulating service at 15 psig or less: select pressure drop equal to 80% of inlet psig.
 - 3) Modulating service at 16-50 psig: select pressure drop equal to 50% of inlet psig.
 - 4) Modulating service at over 50 psig: select pressure drop as scheduled on drawings.
- G. Binary Temperature Devices
 - 1. Low-Voltage Space Thermostats: Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 55°F-85°F setpoint range, 2°F maximum differential, and vented ABS plastic cover.
 - 2. Line-Voltage Space Thermostats: Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 55°F-85°F setpoint range, 2°F maximum differential, and vented ABS plastic cover.
 - 3. Low-Limit Thermostats: Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 20 ft long. Element shall sense temperature in each 1 ft section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.
- H. Temperature Sensors

1. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
 2. Duct Sensors: Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 5 ft in length per 10 ft² of duct cross-section.
 3. Immersion Sensors: Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
 4. Space Sensors: Space sensors shall have setpoint adjustment, override switch, display, and communication port as shown.
 5. Differential Sensors: Provide matched sensors for differential temperature measurement.
- I. Humidity Sensors
1. Duct and room sensors shall have a sensing range of 20%-80%.
 2. Duct sensors shall have a sampling chamber.
 3. Outdoor air humidity sensors shall have a sensing range of 20%-95% RH and shall be suitable for ambient conditions of 40°F-170°F.
 4. Humidity sensors shall not drift more than 1% of full scale annually.
- J. Flow Switches
1. Flow-proving switches shall be paddle (water service only) or differential pressure type (air or water service) as shown. Switches shall be UL listed, SPDT snap-acting, and pilot duty rated (125 VA minimum).
 - a. Paddle switches shall have adjustable sensitivity and NEMA 1 enclosure unless otherwise specified.
 - b. Differential pressure switches shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.
- K. Relays
1. Control Relays: Control relays shall be plug-in type, UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
 2. Time Delay Relays: Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable $\pm 100\%$ from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.
- L. Override Timers
1. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0-6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.
- M. Current Transmitters
1. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A,

- 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.
2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
 3. Unit shall be split-core type for clamp-on installation on existing wiring.
- N. Current Transformers
1. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.
 2. Transformers shall be available in various current ratios and shall be selected for $\pm 1\%$ accuracy at 5 A full-scale output.
 3. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.
- O. Voltage Transmitters
1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.
 2. Adjustable full-scale unit ranges shall be 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.
 3. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating
- P. Voltage Transformers
1. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.
 2. Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide $\pm 0.5\%$ accuracy at 24 Vac and 5 VA load.
 3. Windings (except for terminals) shall be completely enclosed with metal or plastic.
- Q. Power Monitors
1. Power monitors shall be three-phase type and shall have three-phase disconnect and shorting switch assembly, UL listed voltage transformers, and UL listed split-core current transformers.
 2. Power monitors shall provide selectable output: rate pulse for kWh reading or 4-20 mA for kW reading. Power monitors shall operate with 5 A current inputs and maximum error of $\pm 2\%$ at 1.0 power factor or $\pm 2.5\%$ at 0.5 power factor.
- R. Current Switches
1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.
- S. Pressure Transducers
1. Transducers shall have linear output signal and field-adjustable zero and span.
 2. Continuous operating conditions of positive or negative pressure 50% greater than calibrated span shall not damage transducer sensing elements.

3. Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 150 psi. Transducer shall have 4-20 mA output, suitable mounting provisions, and block and bleed valves.
 4. Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 150 psi. Over-range limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall have 4-20 mA output, suitable mounting provisions, and 5-valve manifold.
- T. Differential Air Pressure Switches
1. Differential air pressure switches shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.
- U. Differential Water Pressure Switches
1. Differential water pressure switches shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.
- V. Differential Pressure Transmitters
1. Transmitter shall be a high output, low differential pressure transmitter designed for wet to wet differential pressure measurements of liquids or gases.
 2. Transmitter shall provide both visual monitoring and electronic control of differential pressure.
 3. Transmitter shall contain a fast response capacitance sensor, and signal conditioning electronic circuitry necessary for providing a highly accurate, linear analog output proportional to pressure.
 4. All parts exposed to pressure media shall be stainless steel and elastomer seals. Signal circuit shall be two wire, 4-20mA with 1/4"-18NPT internal connections.
- W. Pressure-Electric (PE) Switches
1. PE switches shall be UL listed, pilot duty rated (125 VA minimum) or motor control rated, metal or neoprene diaphragm actuated, operating pressure rated for 0-25 psig, with calibrated scale minimum setpoint range of 2-18 psig.
 2. Provide one- or two-stage switch action (SPDT, DPST, or DPDT) as required by application.
 3. Switches shall be open type (panel-mounted). Exception: Switches shall be enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.
 4. Each pneumatic signal line to PE switches shall have permanent indicating gauge.
- X. Air Flow Measuring Stations
1. Station shall continuously monitor airflow.
 2. Station shall contain multiple total and static pressure sensors positioned in a log-Tchebycheff pattern.
 3. Station shall be fabricated of 14-gauge galvanized steel with mounting flanges suitable for insertion into ductwork.
 4. Station shall be outfitted with an open parallel cell air straightener equalizer.
 5. Station shall measure airflow rates with an accuracy of $\pm 2\%$.
 6. Maximum allowable pressure drop shall be 0.085 in. w.c. at 2000 fpm.

- Y. Water Flow Measuring Stations
 1. Provide insertion type tubing or paddle wheel flow sensing device.
 2. Unit to generate not more than 10 pulses per second at 10 FPS flow rate for input directly to the DDC Controller.
 3. Calibrate device for flow rate based on the pipe size. Overall accuracy shall be $\pm 3\%$ of the absolute flow.
 4. Install with isolation valves for the removal of sensor for servicing.
 5. Furnish signal conditioner compatible with DDC Controller

- Z. Start-Stop Push Buttons: Maintain or momentary to perform the required functions (Green: On; Red: Off).

- AA. Protective Guards: Provide on all controllers or transmitters in corridors, lobbies, meeting rooms, toilet rooms, instruction rooms and similar areas with vandalproof screws and finished in color selected by A/E.

- BB. Local Control Panels
 1. Indoor control panels shall be fully enclosed NEMA 1 construction with hinged door key-lock latch and removable sub-panels. All exterior control panels shall be NEMA 3R, 18-gauge stainless steel . A common key shall open each control panel and sub-panel.
 2. Prewire internal and face-mounted device connections with color-coded stranded conductors tie-wrapped or neatly installed in plastic troughs. Field connection terminals shall be UL listed for 600 V service, individually identified per control and interlock drawings, with adequate clearance for field wiring.
 3. Each local panel shall have a control power source power switch (on-off) with overcurrent protection.
 4. Panel shall be identified with engraved nameplate on face.

2.10 WIRING

- A. Beyond that furnished under Division 16, provide herein as necessary to accomplish the intent and operations called-out.

- B. The controls contractor shall be responsible (bear the cost and furnish) for all wiring (regardless of voltage), conduit, panels, and electrical accessories required by the control system. The controls contractor shall work closely with the electrical contractor to ensure sufficient capacity exists and main panels, transformers, and substations.

- C. Use cables and/or individual conductors; however, each wire within a cable separately identify/separately color code from all other wires within that cable. Color coding may be repeated in other cables, except that identical cables shall be separately identifiable by coding of the cable. Provide conductors encased in a continuous "mylar" sheath where cables are used.

- D. Wire sizes for trunk cables shall be not less than No. 16 AWG stranded for system selection power, No. 22 AWG solid shielded for intercom, No. 20 AWG solid sheathed for thermocouples and No. 19 AWG for humidity indication and for function selection initiation and operation.

- E. Provide premium grade (plus or minus 3/4 degree F) copper for thermocouple wire in cables. Provide 0.16 PVC minimum and cable jackets 0.040 minimum for insulation for individual wires.
- F. All wiring, regardless of the voltage, must be run in minimum 1/2 inch EMT conduit; refer to Division 16 for requirements.
- G. Secure nameplates to all switches, indicating lights and control devices (self-tapping screws or bolts) to identify the items. Provide engraved laminated plastic, black nameplates with white letters.
- H. Fiber Optic Cable System
 1. Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.
 2. Connectors. Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Thoroughly examine project plans for control device and equipment locations. Report discrepancies, conflicts, or omissions to Architect or Engineer for resolution before starting rough-in work.
- B. Inspect site to verify that equipment can be installed as shown. Report discrepancies, conflicts, or omissions to Engineer for resolution before starting rough-in work.
- C. Examine drawings and specifications for work of others. Report inadequate headroom or space conditions or other discrepancies to Engineer and obtain written instructions for changes necessary to accommodate this work with work of others. Controls Contractor shall perform at his expense necessary changes in specified work caused by failure or neglect to report discrepancies.
- D. Controls Contractor shall be responsible for work and equipment until inspected, tested, and accepted. Protect material not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.
- E. Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.
- F. Life Safety

1. Duct smoke detectors required for air handler shutdown are provided under the fire alarm specification(s). Interlock smoke detectors to air handlers for shutdown as specified in the sequence of operation.
 2. Smoke dampers and actuators required for duct smoke isolation are furnished under this section. Interlock smoke dampers to air handlers as specified in the sequence of operation.
 3. Fire and smoke dampers and actuators required for fire-rated walls are provided under the ductwork accessories specification. Fire and smoke damper control is provided under the fire alarm specification(s).
- G. Coordination with Other Controls: Integrate with and coordinate controls and control devices furnished or installed by others as follows:
1. Communication media and equipment shall be provided as specified herein.
 2. Each supplier of a controls product shall configure, program, start up, and test that product to meet the sequences of operation described in the Sequences of Operation regardless of where within the contract documents those products are described.
 3. Coordinate and resolve incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
 4. Controls Contractor shall be responsible for integration of control products provided by multiple suppliers regardless of where integration is described within the contract documents.
- H. Emergency Power and Protection:
1. The contractor is advised that some control panels/cabinets, controllers, damper actuators, and the like have been identified on the drawings or within the scope of this project as having their line voltage power supply from an emergency power source.
 2. The contractor must provide line voltage power supply from an emergency power source to all system panels/cabinets, controllers, damper actuators, and the like where it is required by the Authority Having Jurisdiction or identified within the scope of this project.
 3. All such control components relying on volatile memories or the like must also be supplied with uninterruptible power sources (UPS) of sufficient duration to span 15-minute primary power interruptions and all elements of the control system susceptible to power surges must also be protected with conditioners, suppressors, or other approved means.
 4. All control wiring associated with the any smoke control system from the controller source out to and including all system devices shall be supervised

3.2 INSTALLATION

- A. General
1. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.
 2. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.
 3. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.

4. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.
 5. Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.
 6. Provide a separate controller for each air handling unit or other HVAC system. Building controllers and custom application controllers shall be selected to provide a minimum of 15% spare Input/Output point capacity for each point type found at each location. If inputs/outputs are not universal, 15% of each type is required.
 7. Install software in controllers and in operator workstation. Implement all features of programs to specified requirements and appropriate to sequence of operation.
- B. Electrical
1. Provide power to all control devices regardless of voltage.
 2. Provide with minimum 120 volts AC, 15 Amp dedicated emergency power circuit to each programmable controller.
 3. Provide conduit and electrical wiring in accordance Electrical Specifications. All wiring, regardless of the voltage, must be run in minimum 1/2 inch EMT conduit.
- C. Installation of Sensors
1. Install sensors according to manufacturer's recommendations.
 2. Install room temperature sensors on concealed junction boxes properly supported by wall framing with the center of the device at 42" AFF.
 3. Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas.
 4. Use averaging sensors in mixing plenums and hot and cold decks. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a capillary clip.
 5. Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide a minimum of one foot (1') of sensing element for each square foot of coil area.
 6. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells. Provide lagging extensions on all temperature sensor wells on insulated piping systems.
 7. Install outdoor air temperature sensors on north wall at designated location with sun shield.
 8. Differential Air Static Pressure Sensors:
 - a. Supply Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
 - b. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
 - c. Building Static Pressure. Pipe pressure sensor's low-pressure port to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe high-pressure port to a location behind a thermostat cover.
 - d. Piping to pressure transducer pressure ports shall contain a capped test port adjacent to transducer.

- e. Pressure transducers, except those controlling VAV boxes, shall be located in control panels, not on monitored equipment or on ductwork. Mount transducers in a vibration-free location accessible for service without use of ladders or special equipment.
 - f. Mount gauge tees adjacent to air and water differential pressure taps. Install shut-off valves before tee for water gauges.
9. Install duct smoke detectors according to manufacturer's recommendations and in accordance with NFPA codes.
Duct detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.
- D. Installation of Actuators
- 1. Mount actuators and adapters according to manufacturer's recommendations.
 - 2. Electric and Electronic Damper Actuators. Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation. Link actuators according to manufacturer's recommendations.
 - a. For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.
 - b. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, then tighten linkage.
 - c. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - d. Provide necessary mounting hardware and linkages for actuator installation.
 - 3. Valve Actuators. Connect actuators to valves with adapters approved by actuator manufacturer.
- E. Installation of Smoke Dampers and Combination Fire/Smoke Dampers
- 1. Installation of smoke dampers and combination fire/smoke dampers shall be done under the ductwork accessories section of the specification (by the mechanical contractor). However, this controls contractor shall provide power for these devices according to paragraph 1.1D, above. Power shall come from a source connected to an emergency power source. Coordinate with Electrical contractor.
- F. Identification of Hardware and Wiring
- 1. Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 2 in. of termination.
 - 2. Label pneumatic tubing at each end within 2 in. of termination with a descriptive identifier.
 - 3. Permanently label or code each point of field terminal strips to show instrument or item served.
 - 4. Label control panels with minimum ½ in. letters on laminated plastic nameplates.
 - 5. Label each control component with a permanent label. Label plug-in components such that label remains stationary during component replacement.

6. Label room sensors related to terminal boxes or valves with nameplates.
7. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
8. Label identifiers shall match record documents

3.3 PROGRAMMING

Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index. The naming convention format shall be "*AA.BBB.CCDDE*" described as follows:

- AA** Used to designate the location of the point within the building such as mechanical room, wing, or floor, or the building itself in a multi-building environment.
- BBB** Used to designate the mechanical system with which the point is associated (e.g. A01, HTG, CLG, LTG).
- CC** Represents the equipment or material referenced (e.g. SF for supply fan, RW for return water, EA for exhaust air, ZN for zone).
- D or DD** May be used for clarification or for identification if more than one CC exists (e.g. SF10, ZNB).
- E** Represents the action or state of the equipment or medium (e.g. T for temperature, H for humidity, C for control, S for Status, D for damper control, I for current).

- A. Software Programming
 1. Programming shall provide actions for each possible situation. Graphic- or parameter-based programs shall be documented. Text-based programs shall be modular, structured, and commented to clearly describe each section of the program.
 2. Provide application programming that adheres to sequences of operation. Program documentation or comment statements shall reflect language used in sequences of operation.
 3. Provide system programming necessary for system operation.
- B. Operator Interface
 1. Standard Graphics. Provide graphics as specified herein. Show on each equipment graphic input and output points and relevant calculated points. Point information on graphics shall dynamically update.
 2. Install, initialize, start up, and troubleshoot operator interface software and functions (including operating system software, operator interface database, and third-party software installation and integration required for successful operator interface operation).

3.4 CALIBRATION AND TESTING

- A. After completion of the control installation, calibrate and test thermostats, control valves, motors, controllers and other items furnished, subject to approval.
- B. Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any or all startup testing.

1. Calibrate and prepare for service each instrument, control, and accessory equipment furnished under this section.
 2. Verify that control wiring is properly connected and free of shorts and ground faults. Verify that terminations are tight.
 3. Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.
 4. Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.
 5. Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.
 6. Prepare a log documenting startup testing of each input and output device, with technician's initials certifying each device has been tested and calibrated.
 7. Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.
 8. Alarms and Interlocks:
 - a. Check each alarm with an appropriate signal at a value that will trip the alarm.
 - b. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.
 - c. Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.
- C. Test and Balance: The complete controls systems shall be ready for test and balance before test and balance work may begin.
1. Furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
 2. Provide training in use of tools. The training shall be a minimum of 4 hours.
 3. Provide a qualified technician to assist in the test and balance process.
 4. The tools used in the test and balance process will be returned at the completion of the testing and balancing.
- D. Perform, in conjunction with the Test and Balance Trades, complete control system commissioning (as described in ASHRAE Applications Manual, 2003 edition, Chapter 42 – New Building Commissioning and as required by ASHRAE Guideline 1-1996 - Building Commissioning), to include verification of proper sequencing and operation of all control components.

3.5 DEMONSTRATION AND TRAINING

- A. Provide basic initial operator training for 2 persons on data display, alarm and status descriptors, requesting data, execution commands and log requests. Include a minimum of 8 hours instructor time. Provide training on site.
- B. Provide a minimum of Two 4-hour follow up visits at Owners discretion.
- C. Demonstrate complete and operating system to Owner

HOU HOUSTON ARFF STATION #81
Project No. 715E-009

DIRECT-DIGITAL CONTROL SYSTEMS FOR HVAC

END OF SECTION

**SECTION 260800
COMMISSIONING OF ELECTRICAL SYSTEMS**

PART 1 - - GENERAL

1.1 SECTION INCLUDES

- A. The Cx activities shall follow all requirements as defined in Section 01 91 13 GENERAL COMMISSIONING REQUIREMENTS.
- B. The section below describes unique Cx activities to the Electrical Systems and the electrical portions of the mechanical systems. The Contractor shall follow all provisions of 01 9113 when meeting the requirements of this specification. Where conflicts may exist between the two specifications, the more restrictive requirement is to be met.
- C. Division 26 subcontractor shall provide full capacity Load Banks for Uninterruptible Power Supply (UPS) Systems functional testing. Full capacity Load Banks may be required during separate testing periods (two or more) depending on construction completion and equipment readiness for testing. Provide full capacity inductive/resistive Load Banks for a minimum of one week for commissioning functional testing to allow for potential weather events delaying testing.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide all necessary test equipment to confirm proper operation of the Electrical Systems.
- B. All testing equipment shall be properly calibrated, and documentation of such calibration shall be submitted prior to any verification testing.
- D. Division 26 subcontractor shall provide full capacity Load Banks for Uninterruptible Power Supply (UPS) Systems functional testing. Full capacity Load Banks may be required during separate testing periods (two or more) depending on construction completion and equipment readiness for testing. Provide full capacity inductive/resistive Load Banks for a minimum of one week for commissioning functional testing to allow for potential weather events delaying testing.

PART 3 - EXECUTION

3.1 PARTICIPATION IN Cx

- A. The Division 26 subcontractor shall take the lead in Cx of the following Electrical Systems:
 - 1. Lighting Control Systems

2. 800A Main Distribution Panel
 3. Generator/ATS
 4. Transformers
 5. UPS
- B. The Division 26 subcontractor and Lighting Control System Vendor/Authorized Manufacturer Representative shall demonstrate complete operation of Lighting Control Systems indicated separate from and in addition to any other required Owner Demonstrations or Owner Training (i.e., Lighting Control System Vendor/Authorized Manufacturer Representative shall include separate site visit trips for Cx functional testing and lighting level measurements).
- C. Division 26 subcontractor shall fully support after-hours (night-time) testing such as “black-site” testing as directed by the Prime Constructor under the supervision of the CxA. Additional afterhours testing may be required if initial tests fail to pass.
- D. Coordinate with the Division 23 and BAS subcontractors for performing and documenting pre-functional checks for each of the equipment items in the scope for Cx.
- E. Division 26 subcontractor and the Division 23 BAS subcontractor are responsible for completing Point-to-Point testing, pre-functional testing, pre-verification testing and functional testing of the BAS interface to the specified Electrical Systems.
- F. Coordinate with the Division 28 Fire Alarm System subcontractors for performing and documenting pre-functional checks for each of the equipment items in the scope for Cx.
- G. Coordinate with the Division 28 Access Control and Video Surveillance subcontractors for performing and documenting pre-functional checks for each of the equipment items in the scope for Cx.

3.2 DISTRIBUTION OF TREND DATA

- A. Trend data from the BAS will be utilized in the Cx activities. Contractor shall provide at least 1 full week of trend data to the Cx Team no later than 1 week before scheduling the functional performance testing. The Cx Team will analyze the trend data from the equipment and systems to be tested as part of the determination whether the testing can be scheduled.
- B. Trend data shall be recorded at intervals no greater than 15 minutes. The trend data from each field controller shall be polled and stored in a central location with capability of archiving the collected trend data for no less than 3 months of storage. The BAS shall be capable of automated distribution of the trend data configured for no greater than weekly updates of the previous interval of data. Change of Value (COV) trending is not preferred and shall only be acceptable for status or binary command points.
- C. Trend data shall be saved in a non-proprietary format such as csv or txt with consistent organization of the data to include at a minimum the timestamp, BAS system trend

name, value and units. Trend reports shall contain both data represented in tabular format as well as line charting.

3.3 PRE-FUNCTIONAL TEST FORMS

- A. After the initial equipment submittal phase, the CxA shall prepare the pre-functional test forms for each item of equipment as part of the Cx. Review respective pre-functional test forms for accuracy and completeness and provide comments to the General Contractor and CxA.
- B. The following is a sample prefunctional test form:

CHK-1: Automatic Transfer Switch (ATS)

Test Type: Pre-Functional Testing

Test Summary

Unit #	Automatic Transfer Switch (ATS)
Discipline	

Equipment Verification

Equipment / Component	Approved Submittal Data	Installed As Submitted?	Installed Data
Manufacturer			
Model number			
Serial number			
Operating voltage			
Current rating			
Ampacity			
Neutral Configuration			
Transition Type			
Priority			
Close and Withstand Rating			
Software version			

Questionnaire			
#	Question	Answer	Details
Installation			
1	Bypass/isolation switch is installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Electrical Contractor _____
2	Equipment interiors are complete and clean	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Electrical Contractor _____
3	Equipment is secured to concrete housekeeping pad	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Electrical Contractor _____
4	Working clearance: 277/480V - 42" to grounded surface; 48" to exposed live parts	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Electrical Contractor _____
5	Switch provided with test switch to simulate failure of normal source	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Electrical Contractor _____
6	Switch provided with pilot lights to indicate normal and emergency position of transfer switch	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Electrical Contractor _____
7	Switch provided with pilot lights to indicate availability of normal and emergency sources	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Electrical Contractor _____
8	Switch provided with terminal blocks labeling all external connections	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Electrical Contractor _____
9	Transfer switch provided with transfer override switch to cause switch to remain connected to emergency source regardless of condition of normal source	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Electrical Contractor _____
10	Transfer switch provided with a retransfer switch to bypass retransfer time delay	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/> Electrical Contractor _____

#	Question	Answer	Details
11	Remote annunciation is provided and wired to the transfer switch (annunciator panel, BAS)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Elevator Contractor _____
Instrumentation			
1	Verify metering provided as specified	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Electrical Contractor _____
2	Display and control unit are mounted flush or semiflush in instrument compartment door	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Electrical Contractor _____
Identification			
1	Verify label installed as specified	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Commissioning Authority _____
2	Bypass/isolation operating instructions are provided on the front of the unit	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Commissioning Authority _____
3	Verify additional labeling is complete	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Commissioning Authority _____
4	Verify conductors are properly color coded	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	 Commissioning Authority _____

END TEST

1. FUNCTIONAL TEST FORMS

- a. After the finalization of the pre-functional test forms, the CxA shall prepare the functional test forms for each system to be documented as part of the Cx. Review respective functional test forms for accuracy and completeness and provide comments to the General Contractor and CxA.
- b. The following is a sample functional test form:

FPT-1: Automatic Transfer Switch (ATS)

Test Type: **Functional Performance Testing**

Asset Summary

Unit #	Automatic Transfer Switch (ATS)
Discipline	

Questionnaire

#	Question	Answer	Details
Auto Start			
1	PROCEDURE: Open the normal power breaker serving the ATS	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>	
2	VERIFY by visual response that:	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>	
3	ATS LED "Normal Power Available" indicator is off.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	Time delay (2 seconds) occurs prior to start signal being sent to generator system	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	The generator receives start signal following time delay to verify loss of utility power.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	Generator is up to speed and voltage within (~6) seconds of receipt of start signal.	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
7	ATS LED indicates "Emergency Power Available".	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
8	ATS does not transfer to emergency power due to presence of time delay inhibit signal (5 seconds).	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

#	Question	Answer	Details
9	ATS transfers to neutral position for scheduled delay per 263623.2.2.N.2	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
10	At conclusion of time delay, ATS transfers to the emergency source.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Bypass			
1	TEST PROCEDURE: Place transfer switch in bypass (E)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	EXPECTED RESPONSE: Switch bypasses to the emergency source.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	EXPECTED RESPONSE: Bypass is a closed transition process	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input checked="" type="checkbox"/> N/A	
Isolate from Emergency Bypass			
1	TEST PROCEDURE: Move isolation handle to "Isolate"	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	EXPECTED RESPONSE: Transfer switch base is released (for inspection, maintenance, etc.)	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	EXPECTED RESPONSE: Switch base is capable of being replaced into ATS and taken out of Bypass	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Auto Stop			
1	PROCEDURE: Close the normal power breaker serving the ATS.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	The ATS indicates normal power is available.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	Time delay begins to verify stability of normal power (These time delays for Priority 2 ATS's are staggered to provide delays between loads adding from generators to utility - See 263623.2.2.N.2).	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	At end of time delay, ATS transfers to neutral position for scheduled delay per 263623.2.2.N.2	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	At conclusion of time delay, ATS transfers load to normal power	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	ATS indicates both normal and emergency power available.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
7	The generator begins cool down cycle.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
8	The generator automatically stops.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
9	ATS LED "Emergency Power Available" indicator off.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

#	Question	Answer	Details
Bypass (Normal)			
1	TEST PROCEDURE: Place transfer switch in bypass (N)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/>
2	EXPECTED RESPONSE: Switch bypasses to the normal source.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
3	EXPECTED RESPONSE: Switch base is capable of being replaced into ATS and taken out of Bypass	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
Test Start			
1	Prior to generator shutdown, Test Start is initiated.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/>
2	PROCEDURE: Activate test switch in face of ATS.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/>
3	VERIFY by visual response that:	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/>
4	ATS initiates start signal to generator.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
5	Generator is up to speed and voltage within (~6) seconds of receipt of start signal.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
6	The ATS verifies synchronization of normal and emergency sources and transfers the load to emergency power (momentary closed transition).	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
7	The ATS indicates that both normal and emergency power are available.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
Test Stop			
1	PROCEDURE: Restore test switch to normal in face of ATS, if applicable	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/>
2	VERIFY by visual response that:	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	<input type="text"/>
3	Time delay begins to verify stability of normal power.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
4	At conclusion of time delay, ATS verifies synchronization of normal and emergency sources and transfers load to normal power (momentary closed transition).	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
5	ATS indicates both normal and emergency power available.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
6	The generator goes begins cool down cycle.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
7	The generator automatically stops	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>
8	ATS LED "Emergency Power Available" indicator off.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	<input type="text"/>

#	Question	Answer	Details
Metering Communication			
The following metered data shall be communicated to the BMCS System:			
1	Phase to neutral voltages	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	Phase currents	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	Power Factor	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	Peak KW Demand	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
The following ATS status parameters are communicated to the BMCS System:			
1	Generator status	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	ATS Switch Position / Source Connection Status	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	Source 1 Status	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	Source 2 Status	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	ATS Alarm	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

END TEST

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END OF SECTION

SECTION 28 08 00 – COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 WORK OF THIS SECTION

- A. The Cx activities shall follow all requirements as defined in Section 01 91 13 GENERAL COMMISSIONING REQUIREMENTS.
- B. The section below describes unique Cx activities to the Electronic Safety and Security Systems.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide all necessary test equipment to confirm proper operation of the Electronic Safety and Security Systems.
- B. All testing equipment shall be properly calibrated, and documentation of such calibration shall be submitted prior to any verification testing.

PART 3 - EXECUTION

3.1 PARTICIPATION IN CX

- A. The Division 28 subcontractors shall execute the Cx activities of the following Electronic Safety and Security Systems, under the supervision and direction of the CxP:
 - 1. Addressable Fire Alarm Systems
 - 2. Access Control System
 - 3. Video Surveillance Control and Management System
- B. Fire Alarm System Functional Testing will include interface with other systems such as Emergency Power, HVAC Systems, Fire Protection Systems, Fire/Smoke Dampers, Kitchen Equipment, Doors, Security System. Fire Alarm System Functional Testing will include testing each prototypical alarm sequence in each Fire Alarm Zone along with a 20% sampling of notification devices. Fire Alarm System Functional Performance Testing will be conducted in addition to, but separate from, and prior to any required Fire Marshal, Code Official or Authority Having Jurisdiction (AHJ) testing.
- C. Coordinate with the Division 23 and BAS subcontractors for performing and documenting pre-functional checks for each of the items integrated into the electronic safety and security equipment systems in the scope for Cx. This is for the purpose of verifying the overall systems' integration works in accordance with the applicable Building Codes, and the described intent (contract drawings and specifications) of the Architect and Engineer of Record.
- D. Coordinate with the Division 26 subcontractors for performing and documenting pre-functional checks for each of the items integrated into the electronic safety and security equipment systems in the scope for Cx. This is for the purpose of verifying the overall systems' integration works in accordance with the applicable

Building Codes, and the described intent (contract drawings and specifications) of the Architect and Engineer of Record.

3.2 PRE-FUNCTIONAL TEST FORMS

- A. After the initial equipment submittal phase, the CxA shall prepare the pre-functional test forms for each item of equipment as part of the Cx. Review respective pre-functional test forms for accuracy and completeness and provide comments to the General Contractor and CxA.
- B. The following is a sample prefunctional test form:

CHK-2: Fire Alarm (Fire Alarm)

Test Type: **Factory Testing**

Test Summary

Unit #	Fire Alarm
Discipline	

Questionnaire

#	Question	Answer	Details
GENERAL			
1	All fire alarm equipment is clean of all dirt and debris after installation.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	Dedicated branch circuit and connections are mechanically protected for each FA system component	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
3	Circuit disconnect means has a red marking, is accessible to authorized personnel only, and is identified as "Fire Alarm Circuit"	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
4	Emergency power is supplied by maintenance-free batteries requiring no water	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
5	System printer is installed, if required	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
6	For selective notification, circuits are protected for survivability	Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
7	Where applicable, door hold opens are mounted to provide complete contact with magnet	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
8	Remote annunciator is provided	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
CONTROL PANEL			
1	Fire alarm panel is installed with smoke detector provided at each location	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	Display is legible through clear, lockable cabinet door	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
3	Time and date display on FACP are correct, so that events may be time and date stamped with the actual time of activation	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	

#	Question	Answer	Details
4	FACP is installed with LEDs for AC power	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
5	FACP is installed with remote alarm transmission bypass	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
6	FACP is installed with HVAC / smoke damper bypass	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
7	FACP is installed with door holder bypass switch	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
8	FACP is installed with elevator bypass switch	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	

INITIATING DEVICES

1	Manual pull stations are located within 5 feet of each exit doorway opening	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	Smoke / heat detectors are installed with power/ status LED's	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
3	Duct detectors are provided with remote test station with alarm and test capabilities for detector	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
4	No smoke or heat detectors are installed within 36" of any HVAC diffuser or return air opening	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	

NOTIFICATION DEVICES

1	Devices are installed such that loss of any one speaker circuit will not cause the loss of any other speaker circuits in the system	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	Visible notification appliances are located not more than 15' from the end of a corridor, with a separation not greater than 100' between appliances	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
3	An exterior audible alarm is installed above the exterior sprinkler connection	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	

END TEST

3.3 FUNCTIONAL TEST FORMS

- A. After the finalization of the pre-functional test forms, the CxA shall prepare the functional test forms for each system to be documented as part of the Cx. Review respective functional test forms for accuracy and completeness and provide comments to the General Contractor and CxA.
- B. The following is a sample functional test form:

FPT-2: Fire Alarm (Fire Alarm System)

Test Type: **Functional Performance Testing**

Asset Summary

Unit #	Fire Alarm
Discipline	

Questionnaire

#	Question	Answer	Details
Normal Standby			
The follow sequence of operation is derived from 283100 1.1.H., dated 11/13/2017.			
1	Screen displays SYSTEM STATUS: NORMAL with time and date. Power LED glows on steadygreen.	Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A <input type="checkbox"/>	
General Alarm Sequence			
1	VERIFY by visual response that:	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	Continuously operate alarm notification appliances, including voice evacuation notices.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	Identify alarm and specific initiating devices at fire alarm control unit, connect network controlpanels, off- premises network control panels and remote annunciators	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
4	Transmit an alarm signal to the remote alarm receiving station.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	Unlock electric door locks in designated egress paths.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	Release fire shutters, fire and smoke doors held open by magnetic door holders -- from local dedicated smoke detectors only.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
7	Activate voice/ alarm communication system.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
8	Switch heating, ventilating and air conditioning equipment controls to fire-alarm mode.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
9	Activate smoke-control system (smoke management) at firefighters smoke control system panel.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
10	Activate stairwell pressurization systems - from local, dedicated smoke detectors only.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

#	Question	Answer	Details
11	Close smoke dampers in air ducts of designated air-conditioning duct systems.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
12	Recall elevators to primary or alternate recall floors.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
13	Activate emergency shutoffs for gas and fuel supplies	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
14	Record events in the system memory.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Manual Station Alarm Verification			
1	PROCEDURE: Activate a 20% sampling of manual pull stations	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	VERIFY by visual response that general alarm is activated on the floor in alarm, two floors above and one below.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input checked="" type="checkbox"/> N/A	
Smoke Detector Alarm Verification			
1	PROCEDURE: Activate a 20% sampling of automatic sprinkler system water flow switches	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	VERIFY by visual response that general alarm is activated on the floor in alarm, two floors above and one below.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Auto Sprinkler System Water Flow Verification			
1	PROCEDURE: Activate a 20% sampling of automatic sprinkler system water flow switches	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	VERIFY by visual response that general alarm is activated on the floor in alarm, two floors above and one below.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Heat Detector Verification			
1	PROCEDURE: Activate a 20% sampling of heat detectors	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	VERIFY by visual response that general alarm is activated on the floor in alarm, two floors above and one below.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Notification Devices			
1	VERIFY operation of the following devices:	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	Activation of alarm notification appliances, fire safety functions, HVAC, annunciation, smoke control, elevator recall, and suppression systems occurs within 10 seconds after the activation of an initiating device.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

#	Question	Answer	Details
3	Strobe devices are synchronized	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	Audible alarms in area produce a sound level 5 dB above maximum sound level lasting 60 sec or 15 dB above the average ambient sound level.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

Duct Detector Alarm Sequence

The follow sequence of operation is derived from 283100 2.2.F.4.d dated 11/13/2017.

1	Continuously operate alarm notification appliances, including voice evacuation notices.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	Identify alarm and specific initiating devices at fire alarm control unit, connect network control panels, off- premises network control panels and remote annunciators	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	Transmit an alarm signal to the remote alarm receiving station.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	Unlock electric door locks in designated egress paths.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	Release fire shutters, fire and smoke doors held open by magnetic door holders -- from local dedicated smoke detectors only	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	Activate voice/ alarm communication system.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
7	Switch heating, ventilating and air conditioning equipment controls to fire-alarm mode.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
8	Activate smoke-control system (smoke management) at firefighters smoke control system panel.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
9	Activate stairwell pressurization systems - from local, dedicated smoke detectors only.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
10	Close smoke dampers in air ducts of designated air-conditioning duct systems	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
11	Recall elevators to primary or alternate recall floors	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
12	Activate emergency lighting control.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
13	Activate emergency shutoffs for gas and fuel supplies.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
14	Record events in the system memory.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
15	Record events by the system printer.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

AHU Duct Detector

1	PROCEDURE: Activate duct mounted smoke detectors for the indicated air handling units.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
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VERIFY alarm sequence for the following devices

#	Question	Answer	Details
1	H-AHU-1 Supply duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	H-AHU-1 Return duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	H-AHU-2 Supply duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	H-AHU-2 Return duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	H-AHU-3 Supply duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	H-AHU-3 Return duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
7	H-AHU-4 Supply duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
8	H-AHU-4 Return duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
9	H-AHU-5 Supply duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
10	H-AHU-5 Return duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
11	H-AHU-6 Supply duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
12	H-AHU-6 Return duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
13	H-AHU-7 Supply duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
14	H-AHU-7 Return duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
15	H-AHU-8 Supply duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
16	H-AHU-8 Return duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
17	C-AHU-1 Supply duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
18	C-AHU-1 Return duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
19	C-AHU-2 Supply duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
20	C-AHU-2 Return duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
21	C-AHU-B Supply duct mounted smoke detector	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
22		<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

General Alarm Elevator Recall

Elevator recall operation derived from ASME A17.1-2016 2.27.3.2
Phase I Emergency Recall Operation by Fire Alarm Initiating Devices.

1	VERIFY By visual response that:	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	An audible alarm is followed by a voice message on the floor of the alarm, the floor above and below, and a visual signal illuminates at the main FACP in electrical room 22009.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	A visual printout appears at the system printers	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

#	Question	Answer	Details
4	Building evacuation signals illuminate in the zone of alarm, floor above and below.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	Annunciation at the remote annunciator panels.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	All magnetic hold open doors in the fire area are released.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
7	Smoke dampers are released at smoke barriers for area in alarm (except for pull station).	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
8	Stairwell pressurization fans turn on.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
9	Annunciation at graphic workstations.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

Level G (Primary) Elevator Recall

1	PROCEDURE: Activate smoke detector in elevator lobby.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	VERIFY Device is uniquely identified.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	

VERIFY elevators recall to primary egress floor (Level 1) for the following smoke detectors

1	ELEV 12	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	ELEVs 4, 5, 6, 8, 9, 10, 11	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	VERIFY Cab firefighters lamp "hat" is SOLID.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

Level B (Alternate) Elevator Recall

1	PROCEDURE: Activate smoke detector in elevator lobby.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	VERIFY Device is uniquely identified	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

VERIFY elevators recall to alternate egress floor for the following smoke detectors:

1	ELEVs 1, 2, 12, 13, 14	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	ELEVs 4, 5, 6, 8, 9, 10, 11	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	VERIFY Cab firefighters lamp "hat" is SOLID.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

Level 1 (Primary) Elevator Recall

1	PROCEDURE: Activate smoke detector in elevator lobby.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	VERIFY Device is uniquely identified	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

VERIFY elevators recall to primary egress floor (Level 1) for the following smoke detectors:

1	ELEVs 1, 2, 12, 13, 14	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
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#	Question	Answer	Details
2	ELEVs 4, 5, 6, 8, 9, 10, 11	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	VERIFY Cab firefighters lamp "hat" is SOLID.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

Level 2 (Primary) Elevator Recall

1	PROCEDURE: Activate smoke detector in elevator lobby	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
2	VERIFY Device is uniquely identified	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

VERIFY elevators recall to primary egress floor (Level 1) for the following smoke detectors:

1	ELEVs 1, 2, 12	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	ELEVs 4, 5, 6, 8, 9, 10, 11	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	VERIFY Cab firefighters lamp "hat" is SOLID.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

Elev Equip Room (Primary) Elevator Recall

1	PROCEDURE: Activate smoke detector in elevator equipment room.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
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VERIFY elevators recall to primary egress floor (Level 1) for the following smoke detectors

1	ELEVs 1, 2, 12	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	ELEVs 4, 5, 6, 8, 9, 10, 11, 13, 14	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	VERIFY Cab firefighters lamp "hat" is FLASHING	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

Elevator Shaft(Primary) Elevator Recall

1	PROCEDURE: Activate smoke detector at top of elevator shaft.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
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VERIFY elevators recall to primary egress floor (Level 1) for the following smoke detectors

1	Top of elevator shaft for Elevators 1,2	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	Top of elevator shaft for Elevators 4, 5, 6	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	Top of elevator shaft for Elevators 8, 9, 10, 11	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	Top of elevator shaft for Elevators 12	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	Top of elevator shaft for Elevators 13	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	Top of elevator shaft for Elevators 14	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
7	VERIFY Cab firefighters lamp "hat" is FLASHING.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

Elevator Shaft (Alternate) Elevator Recall

#	Question	Answer	Details
1	PROCEDURE: Activate smoke detector at pit of elevator shaft.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
VERIFY elevators recall to alternate egress floor for the following smoke detectors:			
1	Pit of elevator shaft for Elevators 1, 2	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	Pit of elevator shaft for Elevators 4, 5, 6	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	Pit of elevator shaft for Elevators 8, 9, 10, 11	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
4	Pit of elevator shaft for Elevators 12	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
5	Pit of elevator shaft for Elevators 13	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
6	Pit of elevator shaft for Elevators 14	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
7	VERIFY Cab firefighters lamp "hat" is FLASHING.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
Elevator Power Shunt Trip			
1	PROCEDURE: Activate indicated heat detector in elevator equipment rooms.	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	
VERIFY Elevator shunt trip for the following heat detectors:			
1	Heat detector in Elevator Machine Rooms: ELEVs 1, 2, 12	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
2	Heat detector in Elevator Machine Rooms: ELEVs 4, 5, 6, 8, 9, 10, 11, 13, 14	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	
3	VERIFY Cab firefighters lamp "hat" is FLASHING.	<input type="checkbox"/> Pass <input type="checkbox"/> Fail <input type="checkbox"/> N/A	

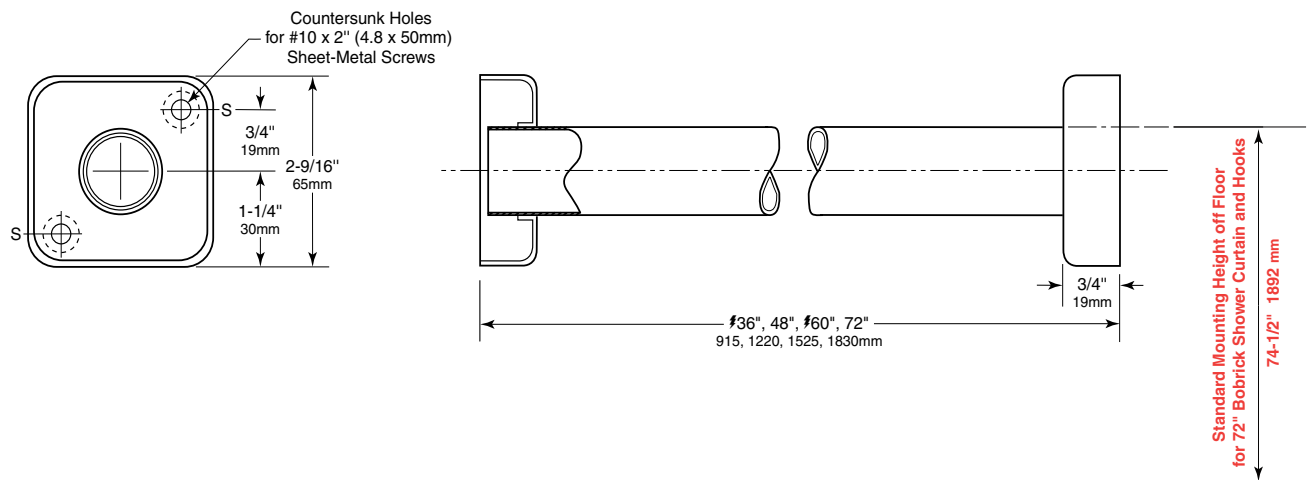
END TEST



Technical Data

ClassicSeries® EXTRA-HEAVY-DUTY SHOWER CURTAIN ROD

B-6047



MATERIALS:

Curtain Rod — 18-8, Type-304, 18-gauge (1.2mm) stainless steel tubing with satin finish. 1-1/4" (32mm) outside diameter. Available in lengths from 36" (915mm) up to 72" (1830mm).

Flanges — 18-8, Type-304, 20-gauge (1.0mm) stainless steel with satin finish. One-piece, die-formed.

INSTALLATION:

Slide flanges onto curtain rod. Position flanges against wall and secure with #10 x 2" (M4.8 x 50mm) Phillips oval-head, stainless steel, sheet-metal screws, furnished by manufacturer, at points indicated by an *S*. For plaster or dry wall construction, provide concealed backing to comply with local building codes, then secure flanges with sheet-metal screws furnished. For other wall surfaces, provide fiber plugs or expansion shields for use with sheet-metal screws furnished, or provide 1/8" (3mm) toggle bolts or expansion bolts.

SPECIFICATION:

Shower curtain rod shall be Type-304, 18-gauge (1.2mm) stainless steel with satin finish and have outside diameter of 1-1/4" (30mm). One-piece, die-formed flanges shall be Type-304, 20-gauge (1.0mm) stainless steel with satin finish.

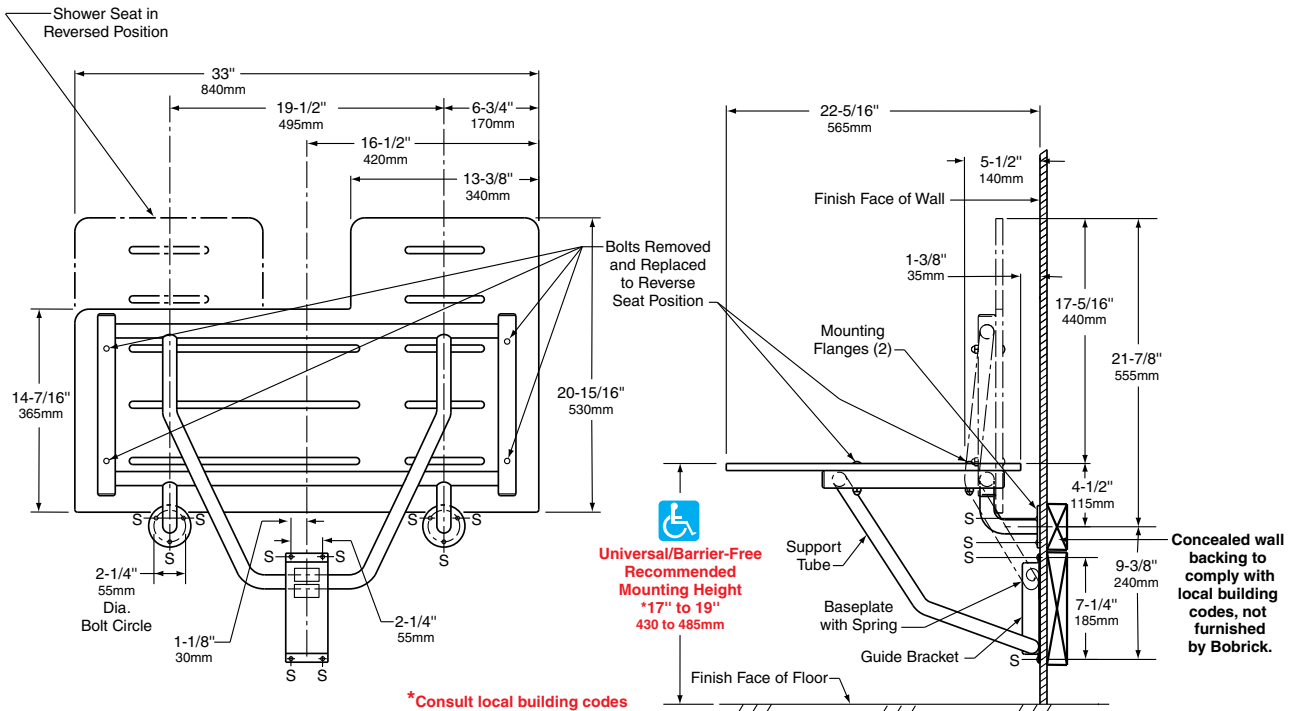
Shower Curtain Rod shall be Model B-6047 x _____ (insert length) of Bobrick Washroom Equipment, Inc., Clifton Park, New York; Jackson, Tennessee; Los Angeles, California; Bobrick Washroom Equipment Company, Scarborough, Ontario; Bobrick Washroom Equipment Pty. Ltd., Australia; and Bobrick Washroom Equipment Limited, United Kingdom.



Technical Data

REVERSIBLE SOLID PHENOLIC FOLDING SHOWER SEAT

B-5181



Left-Hand Seat Shown

MATERIALS:

Seat — One-piece, 1/2" (13mm) thick, solid phenolic with matte-finish, ivory-colored, melamine surfaces and black phenolic-resin core — cannot delaminate. Integral slots for water drainage. Secured to frame with stainless steel carriage bolts and acorn nuts. Reversible for left- or right-hand installation in the field.

Frame — 18-8 S, type-304, stainless steel with satin finish. 16-gauge (1.6mm), 1-1/4" (30mm) square tubing and 18-gauge (1.2mm), 1" (25mm) diameter seamless tubing.

Mounting Flanges (2) — 18-8 S, type-304, 3/16" (5mm) thick stainless steel with satin finish. 3" (75mm) diameter with three mounting screw holes.

Baseplate — 18-8 S, type-304, heavy-gauge stainless steel.

Spring — 17-7, type-301, 24-gauge (0.6mm) stainless steel. Spot-welded to baseplate.

Guide Bracket — 18-8 S, type-304, 16-gauge (1.6mm) stainless steel with satin finish.

continued . . .

OPERATION:

Shower seat folds up against wall when not in use. The spring at the top of the baseplate holds seat in upright position until released by pulling the top of the seat away from the wall. Mounting flanges and guide bracket allow for varying mounting heights and leave the floor clear for easy cleaning. Nonporous solid phenolic seat has slots to permit water to drain, does not splinter or require oiling, and will not support growth of bacteria. Slotless round-head carriage bolts and acorn nuts provide additional safety to user. Bobrick shower seats, when properly installed, have sufficient strength to support 360 lbs., (163 kg) complying with barrier-free accessibility guidelines (including ADAAG in the U.S.A.).

INSTALLATION:

Installation to Wall. Secure unit to wall at points indicated by an S, with the two mounting flanges located at top and the baseplate and guide bracket below. The bottom of the support tube must be positioned within the baseplate and guide bracket before they are secured to wall. Mounting height of shower seat must comply with local building codes.

For stud walls, provide concealed backing to comply with local building codes and secure with #14 x 2-1/2" (6.3 x 65mm) stainless steel sheet-metal screws furnished by manufacturer.

For prefabricated shower stalls, provided adequate backing by the shower stall manufacturer. Secure with #14 x 2-1/2" (6.3 x 65mm) stainless steel mounting screws furnished by manufacturer.

For masonry walls, provide fiber plugs or expansion shields for use with furnished screws, or provide 1/4" (6mm) toggle bolts or expansion bolts.

Caution: These shower seats are no stronger than the anchors and walls to which they are attached and, therefore, must be firmly secured in order to support the loads for which they are intended. Consult and comply with local building codes.

How to Reverse Shower Seat. The solid phenolic shower seat surface may be positioned on the stainless steel frame with the longer 20-15/16" (530mm) side on the left or right. The repositioning of the shower seat surface may be done on the frame before installation on the wall, or after the unit has been installed.

If repositioning the seat surface before installation of the unit on the wall; place entire unit on a horizontal surface; remove carriage bolts and acorn nuts (4); turn seat over reversing position of long and short ends; reinstall carriage bolts and acorn nuts.

If repositioning the seat surface after the unit has been installed on the wall; lower folding seat to horizontal position; remove carriage bolts and acorn nuts (4); turn seat over reversing position of long and short ends; reinstall carriage bolts and acorn nuts.

Important Notes: Support square frame tubes when loosening and removing carriage bolts and acorn nuts; the square frame tubes may separate from the round tubes that support the solid phenolic shower seat. If square and round frame tubes come apart when solid phenolic shower seat is removed, reassemble by placing round frame tube ends in the round holes on the sides of the square frame tubes.

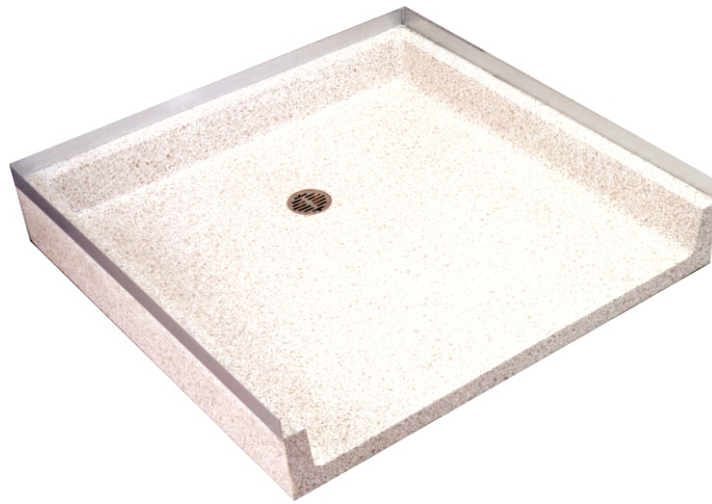
SPECIFICATION:

Reversible folding shower seat shall have a frame constructed of type-304, satin-finish stainless steel that consists of 16-gauge (1.6mm), 1-1/4" (30mm) square tubing and 18-gauge (1.2mm), 1" (25mm) diameter seamless tubing. Seat shall be one-piece, 1/2" (13mm) thick, solid phenolic with matte-finish, ivory-colored, melamine surfaces, and black phenolic-resin core; secured to frame with stainless steel carriage bolts and acorn nuts. Seat shall be reversible for left- or right-hand installation in the field. Shower seat shall be equipped with two 3" (75mm) diameter mounting flanges constructed of type-304, 3/16" (5mm) thick, satin-finish stainless steel; a guide bracket constructed of type-304, 16-gauge (1.6mm), satin-finish stainless steel; and a spring constructed of type-301, 24-gauge (0.6mm) stainless steel that is spot-welded to a baseplate of type-304, heavy-gauge stainless steel. Seat shall remain in upright position when not in use. Shower seat shall comply with barrier-free accessibility guidelines (including ADAAG in the U.S.A.). Manufacturer's service and parts manual shall be provided to the building owner/manager upon request.

Reversible Folding Shower Seat shall be Model B-5181 of Bobrick Washroom Equipment, Inc., Clifton Park, New York; Jackson, Tennessee; Los Angeles, California; Bobrick Washroom Equipment Company, Scarborough, Ontario; Bobrick Washroom Equipment Pty. Ltd., Australia; and Bobrick Washroom Equipment Limited, United Kingdom.



Terrazzo-Ware™ Shower Base - "ADA" Series



SBADA-36-3F

Fixture May Show Some Available Options

Please visit www.acorneng.com for most current specifications.

"ADA" Series Shower Base

Shower Base is an attractive, easy to maintain, spacious shower receptacle. It is designed for durability, for ease of installation, and for use in **ADA**, Americans With Disabilities Act, compliant installations (check with local code authorities). Shower walls by others must be built out to cover shower base shoulders and match 36" square (SBADA-36) or 60" x 30" (SBADA-6030) ADA compliant inside dimensions. **ACORN Terrazzo-Ware™** precast shower bases provide flexibility in configuration and size as required by the design of the building and the specific installation. Custom sizes and colors are also available.

Wheelchair Access to both the 36" square seat type shower stall and the 30" x 60" roll-in type shower stall is provided by an open end. Shower bases are intended to be recessed flush with finished floor. We recommend a floor drain be provided by others near the shower entrance.

Construction is one-piece, precast terrazzo composed of marble chips cast in Portland cement to provide a compressive strength of at least 3,000 PSI seven days after casting. The shower base surface is provided with slip-resistant bathing surface and sealed for years of service. The sides and rear of the fixture come with galvanized tiling flanges that extend 1½" above the 1½" wide shoulder to allow others to construct tiled walls. Shoulders are 6" high and sloped to provide drainage.

Integral Drain is supplied with a removable, stainless steel grid strainer and provides for an inside caulk connection to a 2" pipe. The shower base has coved corners and is sloped to the drain outlet to provide positive drainage. A vandal resistant strainer is optionally available.

GUIDE SPECIFICATION

Provide and install an **ACORN "ADA" Series Shower Base** (specify model number and options) designed for use in **ADA**, Americans With Disabilities Act, compliant installations. Shower walls must be built out to inside dimensions. Shower Base shall be made of precast terrazzo to produce a compressive strength of at least 3,000 PSI seven days after casting. Base shall be provided with slip-resistant bathing surface and sealed. No air holes or pits shall be allowed on the finished surface. Base shall have coved corners and be sloped to the drain outlet for positive drainage. Integral drain shall have a stainless steel strainer and provide for an inside caulk connection to a 2" pipe. The manufacturer will provide to the installer the necessary installation instructions.

Terrazzo-Ware™: Shower Base - "ADA" Series



BASE MODEL & TYPE

SIZE (must specify)

- SBADA-36-3F** 36" Terrazzo Shower Base, Square Three Sides Flanged
- SBADA-6030-3F** 60" x 30" Rectangular Roll-In Type Shower Stall Three Sides Flanged
- SBADA-6036-3F** 60" x 36" Rectangular Roll-In Type Shower Stall Three Sides Flanged
- SBADA-6432-3F** 64" x 32" Rectangular Roll-In Type Shower Stall Three Sides Flanged
- SBADA-6438-3F** 64" x 38" Rectangular Roll-In Type Shower Stall Three Sides Flanged

SUFFIX OPTIONS

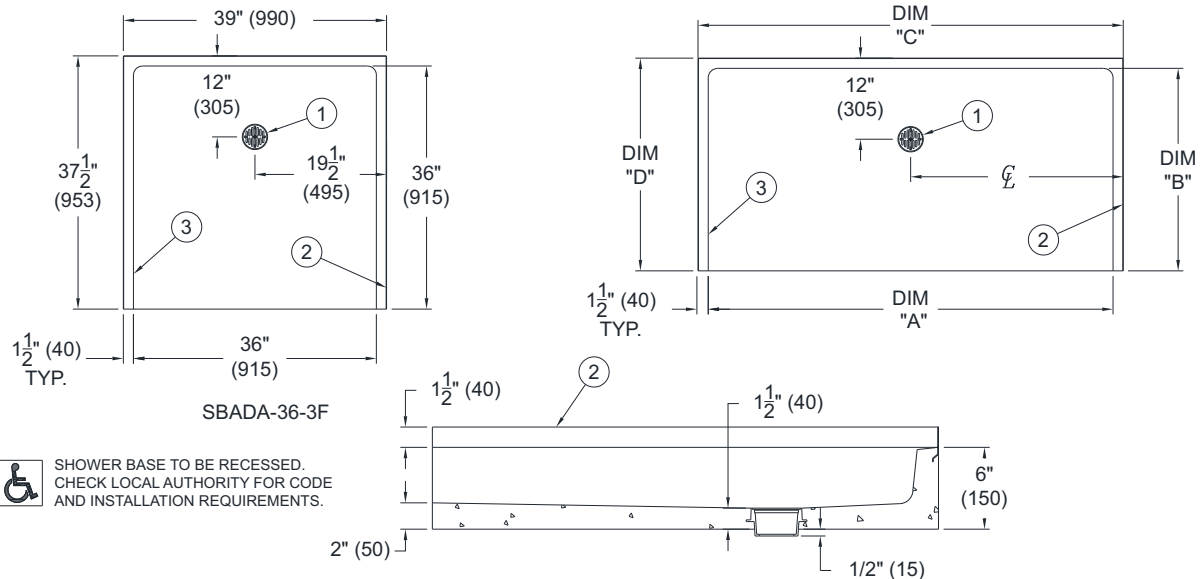
- OC Optional Colors (contact factory)
- VRS Vandal Resistant Strainer

ACCESSORIES

- KDG2 Rubber Drain Gasket for 2" Waste Pipe

Please visit www.acorneng.com for most current specifications.

MODEL NUMBER	TYPE	INTERIOR DIMENSIONS		EXTERIOR DIMENSIONS	
		A - LENGTH	B	C	D
SBADA-36-3F	SQUARE	36" (915)	36" (915)	39" (990)	37-1/2" (953)
SBADA-6030-3F	RECTANGULAR	60" (1525)	30" (760)	63" (1600)	31-1/2" (800)
SBADA-6036-3F	RECTANGULAR	60" (1525)	36" (915)	63" (1600)	37-1/2" (950)
SBADA-6432-3F	RECTANGULAR	64" (1625)	32" (810)	67" (1700)	33-1/2" (850)
SBADA-6438-3F	RECTANGULAR	64" (1625)	38" (965)	67" (1700)	39-1/2" (1005)



SHOWER BASE TO BE RECESSED. CHECK LOCAL AUTHORITY FOR CODE AND INSTALLATION REQUIREMENTS.

TERRAZZO-WARE ADA SERIES SHOWER BASE

NOTES:

1. Integral Drain with Removable Grid Strainer. Drain provides inside caulk connection to 2" Pipe

2. Tiling Flange

3. Shower Base Shoulder

WARNING: Cancer and Reproductive Harm - www.P65Warnings.ca.gov

<p>Important: Installation instructions and current rough-in are furnished with each fixture. Do not rough in without certified dimensions. Dimensions are subject to manufacturer's tolerance of plus or minus 1/4" and change without notice. Acorn assumes no responsibility for use of void or superseded data. © Copyright 2003 Acorn Engineering Company</p>	
<p>Selection Summary</p> <p>Model No. & Option _____</p> <p>Quantity _____</p>	<p>Approved for Manufacturing</p> <p>Company _____ Title _____</p> <p>Signature _____ Date _____</p>



Terrazzo-Ware™ Shower Base - Integral Threshold Series, Rectangular Fixtures



SBR-4832-3F

Fixture May Show Some Available Options

Please visit www.acorneng.com for most current specifications.

Shower Base With Integral Threshold, Rectangular Fixtures

Shower Base is an attractive, easy to maintain, spacious shower receptacle. It is designed for durability and ease of installation. **ACORN Terrazzo-Ware™** precast shower bases provide flexibility in configuration and size as required by the design of the building and the specific installation. Custom sizes and colors are also available.

Integral Threshold provides an attractive entry into the shower. The 3" wide threshold allows installation of a shower door. The three non-threshold sides have galvanized tiling flanges that extend at least 1½" above the 1¼" wide shoulder.

Construction is one-piece, precast terrazzo composed of marble chips cast in Portland cement to provide a compressive strength of at least 3,000 PSI seven days after casting. The shower base surface is provided with slip-resistant bathing surface and sealed to provide years of service. Shoulders are 4" high and sloped to provide drainage.

Integral Drain is supplied with a removable, stainless steel grid strainer and provides for an inside caulk connection to a 2" pipe. The shower base has coved corners and is sloped to the drain outlet to provide positive drainage. A vandal resistant strainer is optionally available.

GUIDE SPECIFICATION

Provide and install an **ACORN Integral Threshold Shower Base** (specify model number and options). Shower Base shall be made of precast terrazzo to produce a compressive strength of not less than 3,000 PSI seven days after casting. Base shall be provided with slip-resistant bathing surface and sealed. No air holes or pits shall be allowed on the finished surface. Base shall have coved corners and be sloped to the drain outlet for positive drainage. Integral drain shall have a stainless steel strainer and provide for an inside caulk connection to a 2" pipe. The manufacturer will provide to the installer the necessary installation instruction.

Terrazzo-Ware™: Shower Base-Integral Threshold Series



BASE MODEL

TYPE & SIZE (must specify)

Long Side Entrance

- SBR-3632-3F** 36" x 32" Terrazzo Shower Base, Rect
- SBR-4232-3F** 42" x 32" Terrazzo Shower Base, Rect
- SBR-4234-3F** 42" x 34" Terrazzo Shower Base, Rect
- SBR-4236-3F** 42" x 36" Terrazzo Shower Base, Rect
- SBR-4832-3F** 48" x 32" Terrazzo Shower Base, Rect
- SBR-4834-3F** 48" x 34" Terrazzo Shower Base, Rect
- SBR-4836-3F** 48" x 36" Terrazzo Shower Base, Rect
- SBR-5432-3F** 54" x 32" Terrazzo Shower Base, Rect
- SBR-6030-3F** 60" x 30" Terrazzo Shower Base, Rect
- SBR-6032-3F** 60" x 32" Terrazzo Shower Base, Rect
- SBR-6034-3F** 60" x 34" Terrazzo Shower Base, Rect
- SBR-6036-3F** 60" x 36" Terrazzo Shower Base, Rect

Short Side Entrance

- SBR-3236-3F** 32" x 36" Terrazzo Shower Base, Rect
- SBR-3642-3F** 36" x 42" Terrazzo Shower Base, Rect
- SBR-3648-3F** 36" x 48" Terrazzo Shower Base, Rect

SUFFIX OPTIONS

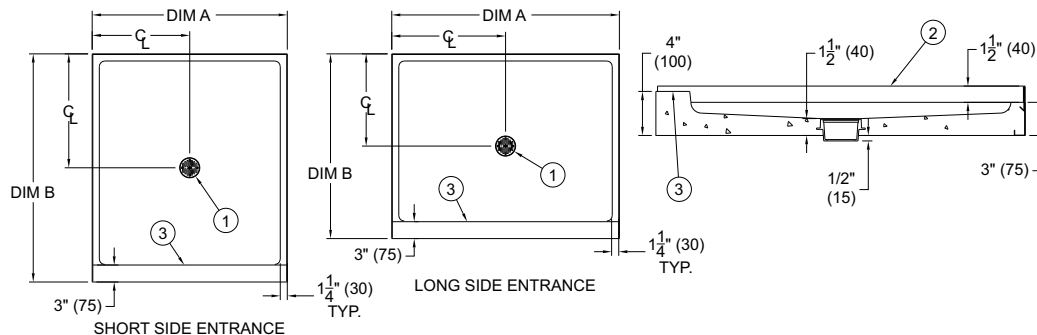
- OC Optional Colors (contact factory)
- VRS Vandal Resistant Strainer

ACCESSORIES

- KDG2 Rubber Drain Gasket for 2" Waste Pipe

Please visit www.acorneng.com for most current specifications.

MODEL NUMBER	TYPE	SIZES/DIMENSIONS		MODEL NUMBER	TYPE	SIZES/DIMENSIONS	
		A - LENGTH	B - WIDTH			A - LENGTH	B - WIDTH
SBR-3632-3F	LONG SIDE ENTRANCE	36" (915)	32" (815)	SBR-6030-3F	LONG SIDE ENTRANCE	60" (1525)	30" (760)
SBR-4232-3F	LONG SIDE ENTRANCE	42" (1065)	32" (815)	SBR-6032-3F	LONG SIDE ENTRANCE	60" (1525)	32" (815)
SBR-4234-3F	LONG SIDE ENTRANCE	42" (1065)	34" (865)	SBR-6034-3F	LONG SIDE ENTRANCE	60" (1525)	34" (865)
SBR-4236-3F	LONG SIDE ENTRANCE	42" (1065)	36" (915)	SBR-6036-3F	LONG SIDE ENTRANCE	60" (1525)	36" (915)
SBR-4832-3F	LONG SIDE ENTRANCE	48" (1220)	32" (815)	SBR-3236-3F	SHORT SIDE ENTRANCE	32" (815)	36" (915)
SBR-4834-3F	LONG SIDE ENTRANCE	48" (1220)	34" (865)	SBR-3642-3F	SHORT SIDE ENTRANCE	36" (915)	42" (1220)
SBR-4836-3F	LONG SIDE ENTRANCE	48" (1220)	36" (915)	SBR-3648-3F	SHORT SIDE ENTRANCE	36" (915)	48" (1065)
SBR-5432-3F	LONG SIDE ENTRANCE	54" (1370)	32" (815)				



TERRAZZO-WARE INTEGRAL THRESHOLD RECTANGULAR SERIES SHOWER BASE

NOTES:

- 1. Integral Drain with Removable Grid Strainer. Drain provides inside caulk connection to 2" Pipe
- 2. Tiling Flange
- 3. Shower Base Threshold

WARNING: Cancer and Reproductive Harm - www.P65Warnings.ca.gov

<p>Important: Installation instructions and current rough-in are furnished with each fixture. Do not rough in without certified dimensions. Dimensions are subject to manufacturer's tolerance of plus or minus 1/4" and change without notice. Acorn assumes no responsibility for use of void or superseded data. © Copyright 2003 Acorn Engineering Company</p>	
<p style="text-align: center;">Selection Summary</p> <p>Model No. & Option _____</p> <p>Quantity _____</p>	<p style="text-align: center;">Approved for Manufacturing</p> <p>Company _____ Title _____</p> <p>Signature _____ Date _____</p>



Terrazzo-Ware™ Shower Base - Integral Threshold Series, Rectangular Fixtures



SBR-4832-3F

Fixture May Show Some Available Options

Please visit www.acorneng.com for most current specifications.

Shower Base With Integral Threshold, Rectangular Fixtures

Shower Base is an attractive, easy to maintain, spacious shower receptacle. It is designed for durability and ease of installation. **ACORN Terrazzo-Ware™** precast shower bases provide flexibility in configuration and size as required by the design of the building and the specific installation. Custom sizes and colors are also available.

Integral Threshold provides an attractive entry into the shower. The 3" wide threshold allows installation of a shower door. The three non-threshold sides have galvanized tiling flanges that extend at least 1½" above the 1¼" wide shoulder.

Construction is one-piece, precast terrazzo composed of marble chips cast in Portland cement to provide a compressive strength of at least 3,000 PSI seven days after casting. The shower base surface is provided with slip-resistant bathing surface and sealed to provide years of service. Shoulders are 4" high and sloped to provide drainage.

Integral Drain is supplied with a removable, stainless steel grid strainer and provides for an inside caulk connection to a 2" pipe. The shower base has coved corners and is sloped to the drain outlet to provide positive drainage. A vandal resistant strainer is optionally available.

GUIDE SPECIFICATION

Provide and install an **ACORN Integral Threshold Shower Base** (specify model number and options). Shower Base shall be made of precast terrazzo to produce a compressive strength of not less than 3,000 PSI seven days after casting. Base shall be provided with slip-resistant bathing surface and sealed. No air holes or pits shall be allowed on the finished surface. Base shall have coved corners and be sloped to the drain outlet for positive drainage. Integral drain shall have a stainless steel strainer and provide for an inside caulk connection to a 2" pipe. The manufacturer will provide to the installer the necessary installation instruction.

Terrazzo-Ware™: Shower Base-Integral Threshold Series



BASE MODEL

TYPE & SIZE (must specify)

Long Side Entrance

- SBR-3632-3F** 36" x 32" Terrazzo Shower Base, Rect
- SBR-4232-3F** 42" x 32" Terrazzo Shower Base, Rect
- SBR-4234-3F** 42" x 34" Terrazzo Shower Base, Rect
- SBR-4236-3F** 42" x 36" Terrazzo Shower Base, Rect
- SBR-4832-3F** 48" x 32" Terrazzo Shower Base, Rect
- SBR-4834-3F** 48" x 34" Terrazzo Shower Base, Rect
- SBR-4836-3F** 48" x 36" Terrazzo Shower Base, Rect
- SBR-5432-3F** 54" x 32" Terrazzo Shower Base, Rect
- SBR-6030-3F** 60" x 30" Terrazzo Shower Base, Rect
- SBR-6032-3F** 60" x 32" Terrazzo Shower Base, Rect
- SBR-6034-3F** 60" x 34" Terrazzo Shower Base, Rect
- SBR-6036-3F** 60" x 36" Terrazzo Shower Base, Rect

Short Side Entrance

- SBR-3236-3F** 32" x 36" Terrazzo Shower Base, Rect
- SBR-3642-3F** 36" x 42" Terrazzo Shower Base, Rect
- SBR-3648-3F** 36" x 48" Terrazzo Shower Base, Rect

SUFFIX OPTIONS

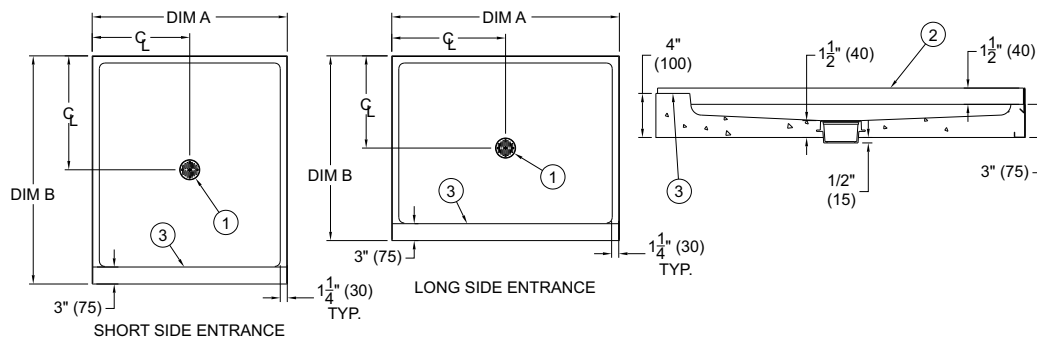
- OC Optional Colors (contact factory)
- VRS Vandal Resistant Strainer

ACCESSORIES

- KDG2 Rubber Drain Gasket for 2" Waste Pipe

Please visit www.acorneng.com for most current specifications.

MODEL NUMBER	TYPE	SIZES/DIMENSIONS		MODEL NUMBER	TYPE	SIZES/DIMENSIONS	
		A - LENGTH	B - WIDTH			A - LENGTH	B - WIDTH
SBR-3632-3F	LONG SIDE ENTRANCE	36" (915)	32" (815)	SBR-6030-3F	LONG SIDE ENTRANCE	60" (1525)	30" (760)
SBR-4232-3F	LONG SIDE ENTRANCE	42" (1065)	32" (815)	SBR-6032-3F	LONG SIDE ENTRANCE	60" (1525)	32" (815)
SBR-4234-3F	LONG SIDE ENTRANCE	42" (1065)	34" (865)	SBR-6034-3F	LONG SIDE ENTRANCE	60" (1525)	34" (865)
SBR-4236-3F	LONG SIDE ENTRANCE	42" (1065)	36" (915)	SBR-6036-3F	LONG SIDE ENTRANCE	60" (1525)	36" (915)
SBR-4832-3F	LONG SIDE ENTRANCE	48" (1220)	32" (815)	SBR-3236-3F	SHORT SIDE ENTRANCE	32" (815)	36" (915)
SBR-4834-3F	LONG SIDE ENTRANCE	48" (1220)	34" (865)	SBR-3642-3F	SHORT SIDE ENTRANCE	36" (915)	42" (1220)
SBR-4836-3F	LONG SIDE ENTRANCE	48" (1220)	36" (915)	SBR-3648-3F	SHORT SIDE ENTRANCE	36" (915)	48" (1065)
SBR-5432-3F	LONG SIDE ENTRANCE	54" (1370)	32" (815)				



TERRAZZO-WARE INTEGRAL THRESHOLD RECTANGULAR SERIES SHOWER BASE

NOTES:

- 1. Integral Drain with Removable Grid Strainer. Drain provides inside caulk connection to 2" Pipe
- 2. Tiling Flange
- 3. Shower Base Threshold

WARNING: Cancer and Reproductive Harm - www.P65Warnings.ca.gov

<p>Important: Installation instructions and current rough-in are furnished with each fixture. Do not rough in without certified dimensions. <small>Dimensions are subject to manufacturer's tolerance of plus or minus 1/4" and change without notice. Acorn assumes no responsibility for use of void or superseded data. © Copyright 2003 Acorn Engineering Company</small></p>	
<p style="text-align: center;">Selection Summary</p> <p>Model No. & Option _____</p> <p>Quantity _____</p>	<p style="text-align: center;">Approved for Manufacturing</p> <p>Company _____ Title _____</p> <p>Signature _____ Date _____</p>



Terrazzo-Ware™ Shower Base - Integral Threshold Series, Square Fixtures



SBS-36-3F

Fixture May Show Some Available Options

Please visit www.acorneng.com for most current specifications.

Shower Base With Integral Threshold, Square Fixtures

Shower Base is an attractive, easy to maintain, spacious shower receptacle. It is designed for durability and ease of installation. **ACORN Terrazzo-Ware™** precast shower bases provide flexibility in configuration and size as required by the design of the building and the specific installation. Custom sizes and colors are also available.

Integral Thresholds on one or two sides (per the specified fixture) provide an attractive entry into the shower. The 3" wide threshold allows easy installation of a shower door. The non-threshold sides have galvanized tiling flanges that extend at least 1½" above the 1¼" wide shoulder.

Construction is one-piece, precast terrazzo composed of marble chips cast in Portland cement to provide a compressive strength of at least 3,000 PSI seven days after casting. The shower base surface is provided with slip-resistant bathing surface and sealed to provide years of service. Shoulders are 4" high and sloped to provide drainage.

Integral Drain is supplied with a removable, stainless steel grid strainer and provides for an inside caulk connection to a 2" pipe. The shower base has coved corners and is sloped to the drain outlet to provide positive drainage. A vandal resistant strainer is optionally available.

GUIDE SPECIFICATION

Provide and install an **ACORN Integral Threshold Shower Base** (specify model number and options). Shower Base shall be made of precast terrazzo to produce a compressive strength of not less than 3,000 PSI seven days after casting. Base shall be provided with slip-resistant bathing surface and sealed. No air holes or pits shall be allowed on the finished surface. Base shall have coved corners and be sloped to the drain outlet for positive drainage. Integral drain shall have a stainless steel strainer and provide for an inside caulk connection to a 2" pipe. The manufacturer will provide to the installer the necessary installation instructions.

Terrazzo-Ware™: Shower Base-Integral Threshold Series



BASE MODEL & TYPE

3 FLANGED SIDES

- SBS-30-3F** 30" Terrazzo Shower Base, Square
- SBS-32-3F** 32" Terrazzo Shower Base, Square
- SBS-34-3F** 34" Terrazzo Shower Base, Square
- SBS-36-3F** 36" Terrazzo Shower Base, Square
- SBS-40-3F** 40" Terrazzo Shower Base, Square
- SBS-42-3F** 42" Terrazzo Shower Base, Square
- SBS-48-3F** 48" Terrazzo Shower Base, Square

2 FLANGED SIDES

- SBS-32-2F** 32" Terrazzo Shower Base, Square
- SBS-36-2F** 36" Terrazzo Shower Base, Square
- SBS-40-2F** 40" Terrazzo Shower Base, Square

SUFFIX OPTIONS

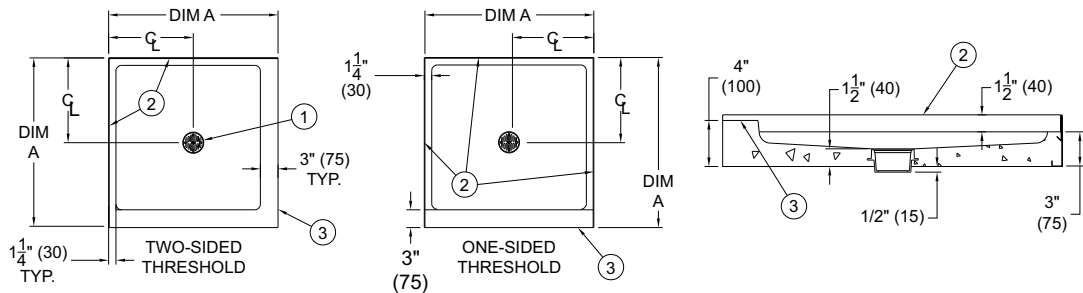
- OC Optional Colors (contact factory)
- VRS Vandal Resistant Strainer

ACCESSORIES

- KDG2 Rubber Drain Gasket for 2" Waste Pipe

Please visit www.acorneng.com
for most current specifications.

MODEL NUMBER	TYPE	THRESHOLD SIDES	FLANGED SIDES	SIZES/DIMENSIONS		MODEL NUMBER	TYPE	THRESHOLD SIDES	FLANGED SIDES	SIZES/DIMENSIONS	
				A - LENGTH						A - LENGTH	
SBS-30-3F	SQUARE	1	3	30"	(760)	SBS-42-3F	SQUARE	1	3	42"	(1065)
SBS-32-3F	SQUARE	1	3	32"	(815)	SBS-48-3F	SQUARE	1	3	48"	(1220)
SBS-34-3F	SQUARE	1	3	34"	(865)	SBS-32-2F	SQUARE	2	2	32"	(815)
SBS-36-3F	SQUARE	1	3	36"	(915)	SBS-36-2F	SQUARE	2	2	36"	(915)
SBS-40-3F	SQUARE	1	3	40"	(1015)	SBS-40-2F	SQUARE	2	2	40"	(1015)



TERRAZZO-WARE INTEGRAL THRESHOLD SQUARE SERIES SHOWER BASE

NOTES:

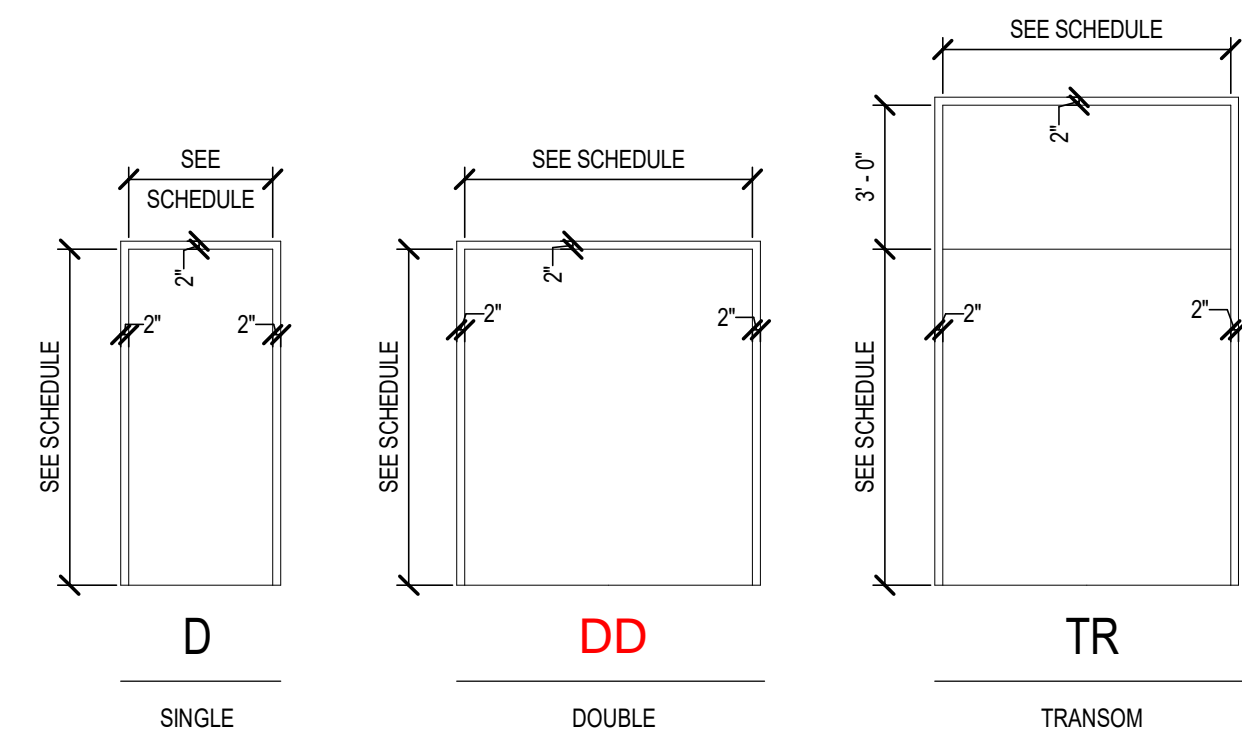
- 1. Integral Drain with Removable Grid Strainer. Drain provides Inside Caulk connection to 2" Pipe
- 2. Tiling Flange
- 3. Shower Base Threshold

WARNING: Cancer and Reproductive Harm - www.P65Warnings.ca.gov

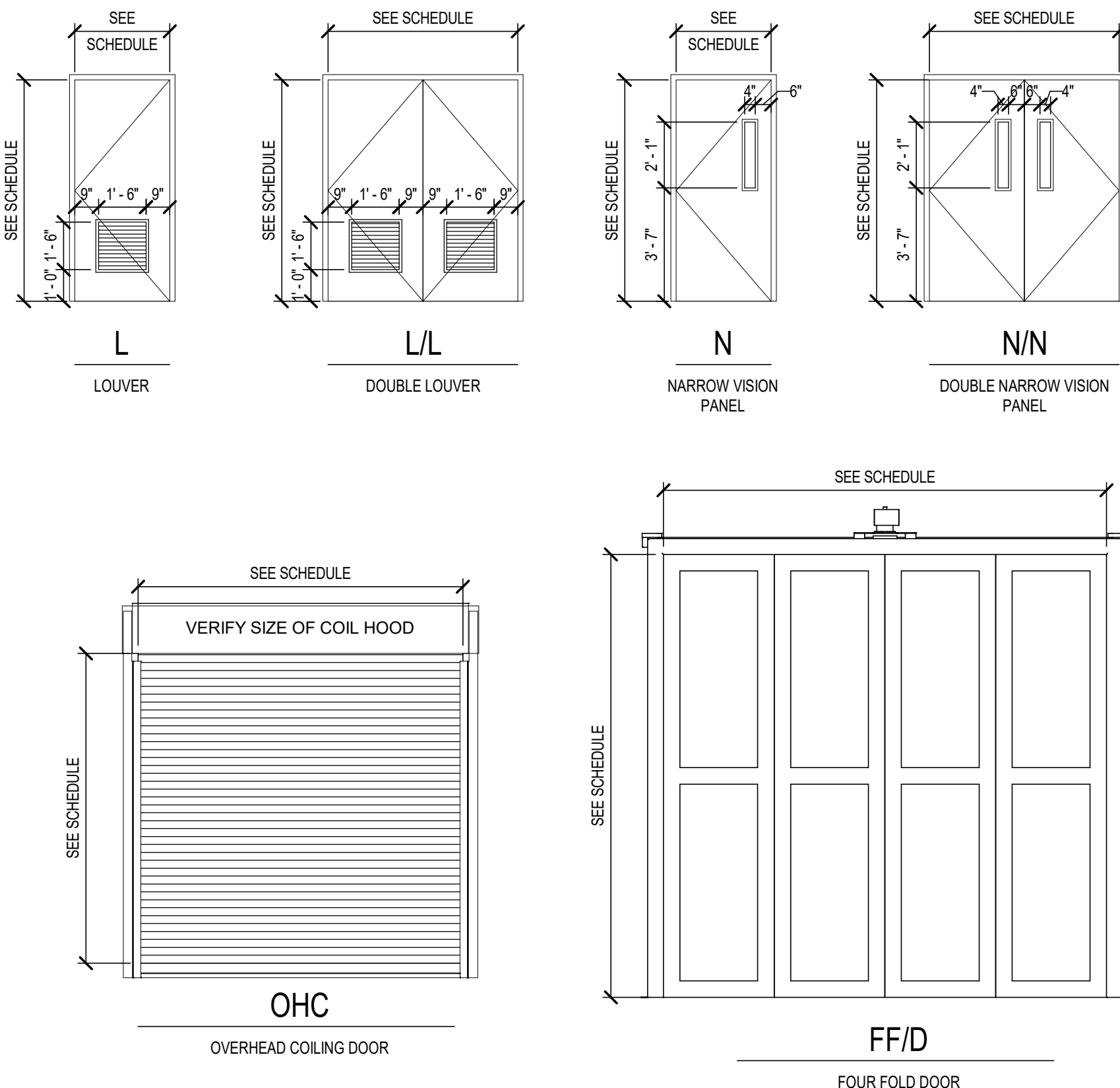
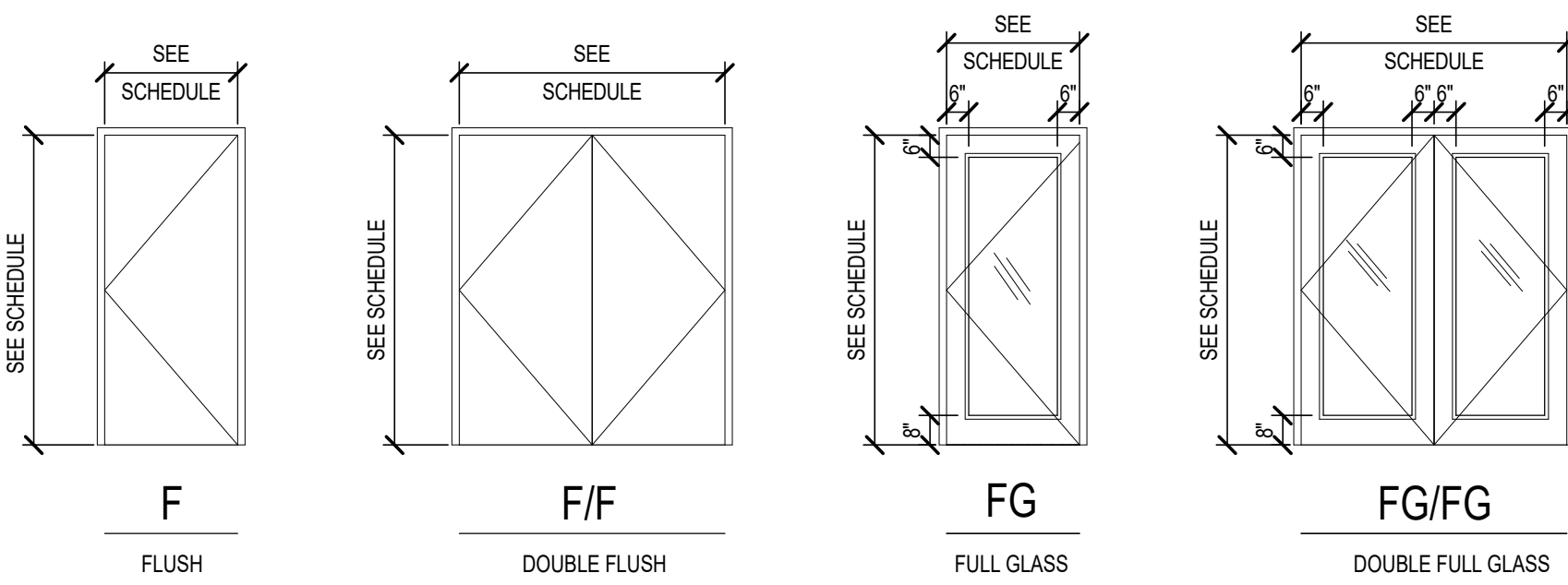
<p>Important: Installation instructions and current rough-in are furnished with each fixture. Do not rough in without certified dimensions. Dimensions are subject to manufacturer's tolerance of plus or minus 1/4" and change without notice. Acorn assumes no responsibility for use of void or superseded data. © Copyright 2004 Acorn Engineering Company</p>	
<p style="text-align: center;">Selection Summary</p> <p>Model No. & Option _____</p> <p>Quantity _____</p>	<p style="text-align: center;">Approved for Manufacturing</p> <p>Company _____ Title _____</p> <p>Signature _____ Date _____</p>

BIM_360/UIS TX_VHXX7109_Houston Airport System_LOA-009 HAS ARFF NO.81/VHXX7109_R21_LA-MEP_SITE.rvt 4/15/2022 6:21:57 PM

DOOR FRAME TYPES



DOOR TYPES



DOOR SCHEDULE - PHASE 2

Table with columns: ROOM NAME, DOOR NUMBER, DOOR TYPE, MATERIAL, WIDTH, HEIGHT, DOOR FINISH, FRAME TYPE, MATERIAL, HARDWARE, FIRE RATING, REMARKS. Lists doors for various rooms like VEST., CORRIDOR, PANTRY, etc.

DOOR SCHEDULE - PHASE 3

Table with columns: ROOM NAME, DOOR NUMBER, DOOR TYPE, MATERIAL, WIDTH, HEIGHT, DOOR FINISH, FRAME TYPE, MATERIAL, HARDWARE, FIRE RATING, REMARKS. Lists doors for APPARATUS BAY, STORAGE, etc.

DOOR SCHEDULE - PHASE 4

Table with columns: ROOM NAME, DOOR NUMBER, DOOR TYPE, MATERIAL, WIDTH, HEIGHT, DOOR FINISH, FRAME TYPE, MATERIAL, HARDWARE, FIRE RATING, REMARKS. Lists doors for APPARATUS BAY, AGENT STORAGE ROOM, etc.

GENERAL NOTES



5885 Rogerdale Road Houston, TX 77072 (281) 721-8400 www.jacobs.com TBPE Firm #2966

REVISIONS

Table with columns: Mark, Date, Description. Lists revision history.

OWNER: HOUSTON AIRPORT SYSTEM TIP-20-219-HOU BSG-2020-223-HOU HOUSTON AIRPORT SYSTEM

CONSULTANT:



HOUSTON AIRPORT SYSTEM PN 715E - 009 ARFF NO. 81 - PHASE 2 - 4 PACKAGE 2 7990 PAUL B. KOONCE ST. HOUSTON, TX 77061

AIP NO:

CIP NO:

HAS NO: PN 715E

Jacobs Project No.: WHXX7109 Drawing Title:

DOOR SCHEDULE AND TYPE

Date: 04/15/22 Designed: GL Drawn: SM Checked: BR Drawing No.: A-603.2



Date: December 10, 2020

To: Laura Zarea, Assoc. AIA, LEED AP BD+C, Project Manager Jacobs
Chandra Daladhuli, PE, PMP, Project Engineer Isani Consultants L.P.

From: R. F. (Frank) Carmichael III, PE, Senior Project Manager HVJ Associates, Inc.

Subject: Pavement Design Addendum
New Drainage System and Underground Conditions
ARFF # 81 HOU
HVJ Project No. HG1710320.2.2

1 Background

HVJ Associates (HVJ) was retained by Jacobs to provide geotechnical and pavement engineering for the renovation of ARFF # 81 at Hobby. Comments received on HVJ's draft report dated September 11, 2020 indicated that a new subsurface chamber drainage system, Stormtech SC-310 with details provided by Advanced Drainage Systems, Inc (ADS) of Houston, Texas was being considered. These details were provided to HVJ by Chandra Daladhuli, PE of Isani Consultants L.P.

Based on a November 6, 2020 meeting between Jacobs, Isani and HVJ, documented in a memorandum by Laura Zarea, Assoc. AIA, of Jacobs, HVJ was asked to provide another alternative PCC cross section thickness design based on the requirements of the ADS SC-310 system and site specific conditions and elevations.

2 Elevations/Materials

A review of the site elevations indicated a Finished Top of Pavement Elevation of 40.5 feet and the Shallowest Flow Line at the Bottom of the ADS chamber to be 36.45 feet. This provides 4.05 feet of elevation to work with for the required system materials and PCC pavement section. A summary of the constraints of the various material types B (embedment stone), C (initial fill), and D (final fill) are provided in the following table based on drawing sheet 3 of 5 of the ADS set.

Layer*	Thickness Inches
Top of pavement to flow line (based on proposed elevations)	48.6
Chamber	16.0
Material B Embedment Stone	6.0
Geotextile	--
Material C Initial Fill	12.0
Material D Final Fill	
Thickness remaining for pavement	14.6

* Based on Drawing developed by ADS

HVJ's pavement design of 9" PCC on 4" HMAC Base over 8" cement stabilized subgrade is a total of 21" thick and is greater than the allowed 14.6" based on elevations and material requirements for the drainage system. However, if 8" of the Material D final fill is cement stabilized and considered part of the pavement section, with the pavement layer being 9" PCC on 4" HMAC Base (13" total), the Material C may be 5.6" to achieve the proposed total depth of 4.05' or 48.6" based on the proposed elevations.

Layer	Thickness Inches
Chamber	16.0
Material B Embedment Stone	6.0
Geotextile	--
Material C Initial Fill	5.6
Material D Final Fill- cement stabilized	8.0
Pavement thickness (9" PCC/4" HMAC)	13.0
Top of pavement to flow line	48.6

HVJ is not familiar with this drainage system and in particular its long term effect on pavement performance. Note 3 under the heading "Notes for Construction Equipment" on the ADS Cover Sheet 1 of 5 (Attachment A) provides directions to the contractor and states: "Full 36" of stabilized cover materials over the chambers is required for dump truck travel and dumping". **The current designs do not meet this criteria since due to design elevations there is only 32.6" of cover material over the chambers, so the contractor must be directed to use means and methods to protect the underlying ADS chambers.** Sheet 3 of 5 also provides directions to the contractor concerning roller sizes and compaction levels of the placement of fill Material C.

HVJ recommended that this requirements be further clarified with the manufacturer and Isani reviewed these requirements with ADS representatives. ADS representatives indicate that these notes are to advise the contractor not to drive heavy loaded dump trucks over the installation construction so as not to damage the installation. HVJ requires that these requirements be added to the general plan notes so that the selected contractor will select means and methods to complete the installation while protecting the integrity of the ADS chambers during the placement of the fill material layers "B" and "C" materials and final pavement layers including the cement stabilized material layer "D" (ADS Drawing is Attachment A to this memorandum).

3 Layer D Stabilization Requirements

Assuming that insitu materials are used for the 8" Material Layer 'D', HVJ recommends stabilizing these materials with 6% Portland cement to achieve a minimum 7 – day compressive strength of 150 psi.

ATTACHMENT A



ADVANCED DRAINAGE SYSTEMS, INC.

SiteASSIST™
by StormTech
FOR STORMTECH
INSTRUCTIONS,
DOWNLOAD THE
INSTALLATION APP



PROJECT INFORMATION	
ENGINEERED PRODUCT MANAGER:	ERNIE CARRASCO 832-948-4112 ERNIE.CARRASCO@ADS-PIPE.COM
ADS SALES REP:	CRAIG VICKERY 281-236-8739 CRAIG.VICKERY@ADS-PIPE.COM
PROJECT NO:	S198890

HOBBY AIRPORT HANGAR PROJECT

HOUSTON, TX

SC-310 STORMTECH CHAMBER SPECIFICATIONS

- CHAMBERS SHALL BE STORMTECH SC-310.
- CHAMBERS SHALL BE ARCH-SHAPED AND SHALL BE MANUFACTURED FROM VIRGIN, IMPACT-MODIFIED POLYPROPYLENE OR POLYETHYLENE COPOLYMERS.
- CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2922 (POLETHYLENE) OR ASTM F2418-16a (POLYPROPYLENE), "STANDARD SPECIFICATION FOR CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
- CHAMBER ROWS SHALL PROVIDE CONTINUOUS, UNOBSTRUCTED INTERNAL SPACE WITH NO INTERNAL SUPPORTS THAT WOULD IMPEDE FLOW OR LIMIT ACCESS FOR INSPECTION.
- THE STRUCTURAL DESIGN OF THE CHAMBERS, THE STRUCTURAL BACKFILL, AND THE INSTALLATION REQUIREMENTS SHALL ENSURE THAT THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, SECTION 12.12, ARE MET FOR: 1) LONG-DURATION DEAD LOADS AND 2) SHORT-DURATION LIVE LOADS, BASED ON THE AASHTO DESIGN TRUCK WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.
- CHAMBERS SHALL BE DESIGNED, TESTED AND ALLOWABLE LOAD CONFIGURATIONS DETERMINED IN ACCORDANCE WITH ASTM F2787, "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS". LOAD CONFIGURATIONS SHALL INCLUDE: 1) INSTANTANEOUS (<1 MIN) AASHTO DESIGN TRUCK LIVE LOAD ON MINIMUM COVER 2) MAXIMUM PERMANENT (75-YR) COVER LOAD AND 3) ALLOWABLE COVER WITH PARKED (1-WEEK) AASHTO DESIGN TRUCK.
- REQUIREMENTS FOR HANDLING AND INSTALLATION:
 - TO MAINTAIN THE WIDTH OF CHAMBERS DURING SHIPPING AND HANDLING, CHAMBERS SHALL HAVE INTEGRAL, INTERLOCKING STACKING LUGS.
 - TO ENSURE A SECURE JOINT DURING INSTALLATION AND BACKFILL, THE HEIGHT OF THE CHAMBER JOINT SHALL NOT BE LESS THAN 2".
 - TO ENSURE THE INTEGRITY OF THE ARCH SHAPE DURING INSTALLATION, a) THE ARCH STIFFNESS CONSTANT AS DEFINED IN SECTION 6.2.8 OF ASTM F2922 SHALL BE GREATER THAN OR EQUAL TO 400 LBS/IN/IN. AND b) TO RESIST CHAMBER DEFORMATION DURING INSTALLATION AT ELEVATED TEMPERATURES (ABOVE 73° F / 23° C), CHAMBERS SHALL BE PRODUCED FROM REFLECTIVE GOLD OR YELLOW COLORS.
- ONLY CHAMBERS THAT ARE APPROVED BY THE SITE DESIGN ENGINEER WILL BE ALLOWED. UPON REQUEST BY THE SITE DESIGN ENGINEER OR OWNER, THE CHAMBER MANUFACTURER SHALL SUBMIT A STRUCTURAL EVALUATION FOR APPROVAL BEFORE DELIVERING CHAMBERS TO THE PROJECT SITE AS FOLLOWS:
 - THE STRUCTURAL EVALUATION SHALL BE SEALED BY A REGISTERED PROFESSIONAL ENGINEER.
 - THE STRUCTURAL EVALUATION SHALL DEMONSTRATE THAT THE SAFETY FACTORS ARE GREATER THAN OR EQUAL TO 1.95 FOR DEAD LOAD AND 1.75 FOR LIVE LOAD, THE MINIMUM REQUIRED BY ASTM F2787 AND BY SECTIONS 3 AND 12.12 OF THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS FOR THERMOPLASTIC PIPE.
 - THE TEST DERIVED CREEP MODULUS AS SPECIFIED IN ASTM F2922 SHALL BE USED FOR PERMANENT DEAD LOAD DESIGN EXCEPT THAT IT SHALL BE THE 75-YEAR MODULUS USED FOR DESIGN.
- CHAMBERS AND END CAPS SHALL BE PRODUCED AT AN ISO 9001 CERTIFIED MANUFACTURING FACILITY.

THIS LAYOUT IS FOR CONCEPTUAL PURPOSES ONLY AND IS NOT INTENDED FOR BIDDING, ESTIMATING OR CONSTRUCTION. IT DOES NOT INCLUDE ELEVATIONS, FLOW RATES OR SURROUNDING TOPOGRAPHY, NOR BEEN REVIEWED BY ADS ENGINEERING.

IMPORTANT - NOTES FOR THE BIDDING AND INSTALLATION OF THE SC-310 SYSTEM

- STORMTECH SC-310 CHAMBERS SHALL NOT BE INSTALLED UNTIL THE MANUFACTURER'S REPRESENTATIVE HAS COMPLETED A PRE-CONSTRUCTION MEETING WITH THE INSTALLERS.
- STORMTECH SC-310 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH SC-310/SC-740/DC-780 CONSTRUCTION GUIDE".
- CHAMBERS ARE NOT TO BE BACKFILLED WITH A DOZER OR AN EXCAVATOR SITUATED OVER THE CHAMBERS. STORMTECH RECOMMENDS 3 BACKFILL METHODS:
 - STONESHOOTER LOCATED OFF THE CHAMBER BED.
 - BACKFILL AS ROWS ARE BUILT USING AN EXCAVATOR ON THE FOUNDATION STONE OR SUBGRADE.
 - BACKFILL FROM OUTSIDE THE EXCAVATION USING A LONG BOOM HOE OR EXCAVATOR.
- THE FOUNDATION STONE SHALL BE LEVELED AND COMPACTED PRIOR TO PLACING CHAMBERS.
- JOINTS BETWEEN CHAMBERS SHALL BE PROPERLY SEATED PRIOR TO PLACING STONE.
- MAINTAIN MINIMUM - 6" (150 mm) SPACING BETWEEN THE CHAMBER ROWS.
- EMBEDMENT STONE SURROUNDING CHAMBERS MUST BE A CLEAN, CRUSHED, ANGULAR STONE 3/4-2" (20-50 mm).
- THE CONTRACTOR MUST REPORT ANY DISCREPANCIES WITH CHAMBER FOUNDATION MATERIALS BEARING CAPACITIES TO THE SITE DESIGN ENGINEER.
- ADS RECOMMENDS THE USE OF "FLEXSTORM CATCH IT" INSERTS DURING CONSTRUCTION FOR ALL INLETS TO PROTECT THE SUBSURFACE STORMWATER MANAGEMENT SYSTEM FROM CONSTRUCTION SITE RUNOFF.

NOTES FOR CONSTRUCTION EQUIPMENT

- STORMTECH SC-310 CHAMBERS SHALL BE INSTALLED IN ACCORDANCE WITH THE "STORMTECH SC-310/SC-740/DC-780 CONSTRUCTION GUIDE".
- THE USE OF CONSTRUCTION EQUIPMENT OVER SC-310 & SC-740 CHAMBERS IS LIMITED:
 - NO EQUIPMENT IS ALLOWED ON BARE CHAMBERS.
 - NO RUBBER TIRED LOADERS, DUMP TRUCKS, OR EXCAVATORS ARE ALLOWED UNTIL PROPER FILL DEPTHS ARE REACHED IN ACCORDANCE WITH THE "STORMTECH SC-310/SC-740/DC-780 CONSTRUCTION GUIDE".
 - WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT CAN BE FOUND IN THE "STORMTECH SC-310/SC-740/DC-780 CONSTRUCTION GUIDE".
- FULL 36" (900 mm) OF STABILIZED COVER MATERIALS OVER THE CHAMBERS IS REQUIRED FOR DUMP TRUCK TRAVEL OR DUMPING.**

USE OF A DOZER TO PUSH EMBEDMENT STONE BETWEEN THE ROWS OF CHAMBERS MAY CAUSE DAMAGE TO THE CHAMBERS AND IS NOT AN ACCEPTABLE BACKFILL METHOD. ANY CHAMBERS DAMAGED BY THE "DUMP AND PUSH" METHOD ARE NOT COVERED UNDER THE STORMTECH STANDARD WARRANTY.

CONTACT STORMTECH AT 1-888-892-2694 WITH ANY QUESTIONS ON INSTALLATION REQUIREMENTS OR WEIGHT LIMITS FOR CONSTRUCTION EQUIPMENT.

CONCEPTUAL LAYOUT

1734	STORMTECH SC-310 CHAMBERS
156	STORMTECH SC-310 END CAPS
6	STONE ABOVE (in)
6	STONE BELOW (in)
40	% STONE VOID
56646	INSTALLED SYSTEM VOLUME (CF) (PERIMETER STONE INCLUDED)
44239	SYSTEM AREA (ft ²)
1680	SYSTEM PERIMETER (ft)

CONCEPTUAL ELEVATIONS

9.83	MAXIMUM ALLOWABLE GRADE (TOP OF PAVEMENT/UNPAVED)
3.83	MINIMUM ALLOWABLE GRADE (UNPAVED WITH TRAFFIC)
3.33	MINIMUM ALLOWABLE GRADE (UNPAVED NO TRAFFIC)
3.33	MINIMUM ALLOWABLE GRADE (BASE OF FLEXIBLE PAVEMENT)
3.33	MINIMUM ALLOWABLE GRADE (TOP OF RIGID PAVEMENT)
2.33	TOP OF STONE
1.83	TOP OF SC-310 CHAMBER
0.50	BOTTOM OF SC-310 CHAMBER
0.00	UNDERDRAIN INVERT
0.00	BOTTOM OF STONE

PROJECT SPECIFIC CONSIDERATIONS:

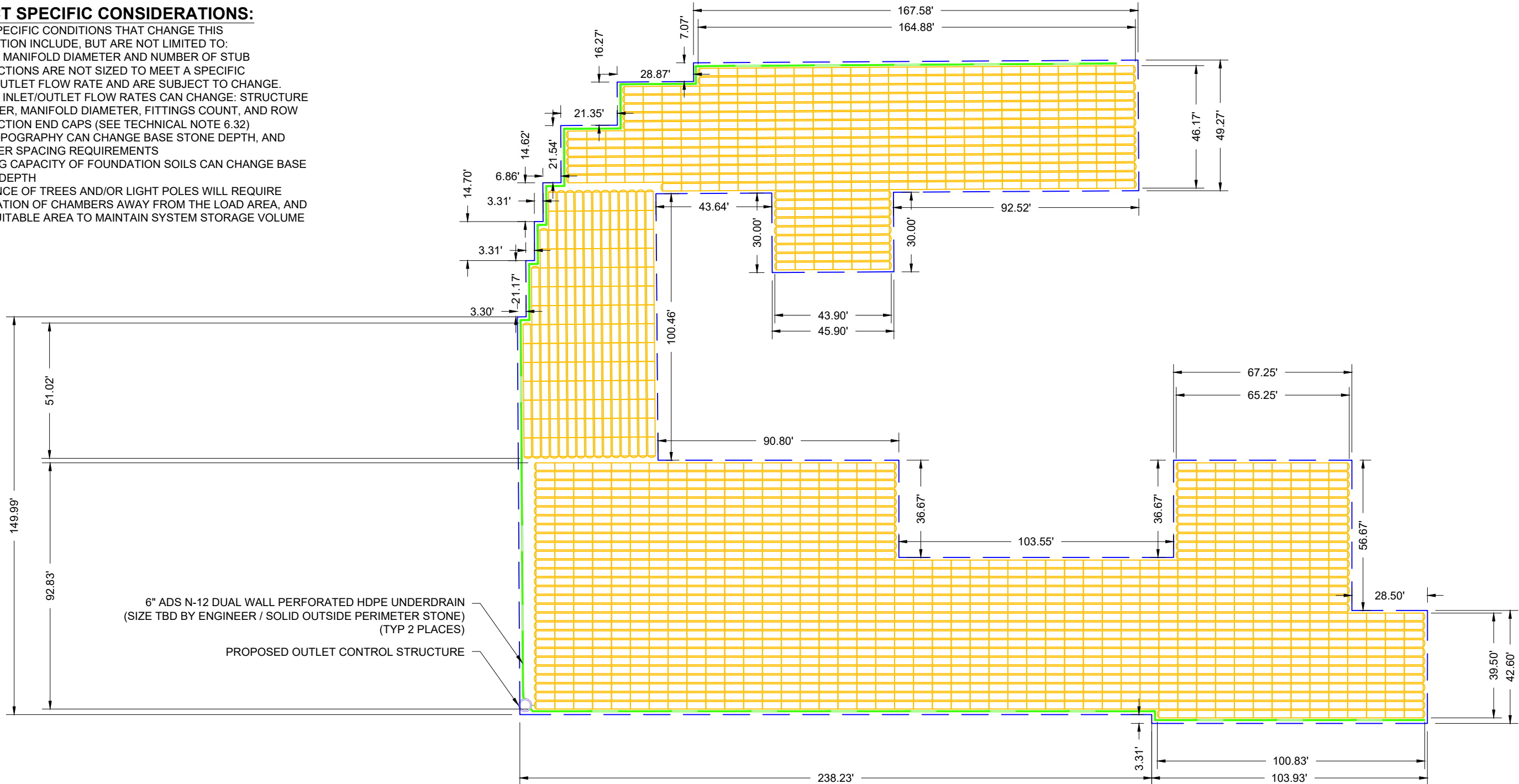
- PROJECT SPECIFIC CONDITIONS THAT CHANGE THIS CONFIGURATION INCLUDE, BUT ARE NOT LIMITED TO:
- SHOWN MANIFOLD DIAMETER AND NUMBER OF STUB CONNECTIONS ARE NOT SIZED TO MEET A SPECIFIC INLET/OUTLET FLOW RATE AND ARE SUBJECT TO CHANGE.
 - DESIGN INLET/OUTLET FLOW RATES CAN CHANGE: STRUCTURE DIAMETER, MANIFOLD DIAMETER, FITTINGS COUNT, AND ROW CONNECTION END CAPS (SEE TECHNICAL NOTE 6.32)
 - SITE TOPOGRAPHY CAN CHANGE BASE STONE DEPTH, AND CHAMBER SPACING REQUIREMENTS
 - BEARING CAPACITY OF FOUNDATION SOILS CAN CHANGE BASE STONE DEPTH
 - PRESENCE OF TREES AND/OR LIGHT POLES WILL REQUIRE RELOCATION OF CHAMBERS AWAY FROM THE LOAD AREA, AND TO A SUITABLE AREA TO MAINTAIN SYSTEM STORAGE VOLUME

NOTES

- MANIFOLD SIZE TO BE DETERMINED BY SITE DESIGN ENGINEER. SEE TECHNICAL NOTE 6.32 FOR MANIFOLD SIZING GUIDANCE.
- DUE TO THE ADAPTATION OF THIS CHAMBER SYSTEM TO SPECIFIC SITE AND DESIGN CONSTRAINTS, IT MAY BE NECESSARY TO CUT AND COUPLE ADDITIONAL PIPE TO STANDARD MANIFOLD COMPONENTS IN THE FIELD.
- THE SITE DESIGN ENGINEER MUST REVIEW ELEVATIONS AND IF NECESSARY ADJUST GRADING TO ENSURE THE CHAMBER COVER REQUIREMENTS ARE MET.
- THIS CHAMBER SYSTEM WAS DESIGNED WITHOUT SITE-SPECIFIC INFORMATION ON SOIL CONDITIONS OR BEARING CAPACITY. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR DETERMINING THE SUITABILITY OF THE SOIL AND PROVIDING THE BEARING CAPACITY OF THE INSITU SOILS. THE BASE STONE DEPTH MAY BE INCREASED OR DECREASED ONCE THIS INFORMATION IS PROVIDED.
- THE STORMTECH SYSTEM DEPICTED DOES NOT INCLUDE WATER QUALITY MEASURES AND/OR DOES NOT PROVIDE THE ABILITY TO BE INSPECTED, CLEANED, AND MAINTAINED. NOT MAINTAINING THE SYSTEM MAY LEAD TO A DECREASE IN STORAGE VOLUME OVER TIME. ADS RECOMMENDS THE USE OF THE ISOLATOR ROW ON ALL STORMTECH SYSTEMS.
- THE SITE DESIGN ENGINEER MUST REVIEW THE PROXIMITY OF THE CHAMBERS TO THE BUILDING/STRUCTURE. NO FOUNDATION LOADS SHALL BE TRANSMITTED TO THE CHAMBERS. THE SITE DESIGN ENGINEER MUST CONSIDER EFFECTS OF POSSIBLE SATURATED SOILS ON BEARING CAPACITY OF SOILS AND SEEPAGE INTO BASEMENTS.
- **NOT FOR CONSTRUCTION:** THIS LAYOUT IS FOR DIMENSIONAL PURPOSES ONLY TO PROVE CONCEPT & THE REQUIRED STORAGE VOLUME CAN BE ACHIEVED ON SITE.

CONCEPTUAL LAYOUT FOR PROPOSED CONVERSION OR SYSTEM BUDGETING AND COMPARISON ONLY. NOT INTENDED FOR ESTIMATING, BIDDING, OR CONSTRUCTION UNLESS APPROVED BY ENGINEER OF RECORD

- DUE TO THE ADAPTATION OF THIS CHAMBER SYSTEM TO SPECIFIC SITE AND DESIGN CONSTRAINTS, IT MAY BE NECESSARY TO CUT AND COUPLE ADDITIONAL PIPE TO STANDARD MANIFOLD COMPONENTS IN THE FIELD.
- THE SITE DESIGN ENGINEER MUST REVIEW ELEVATIONS AND IF NECESSARY ADJUST GRADING TO ENSURE THE CHAMBER COVER REQUIREMENTS ARE MET.



HOBBY AIRPORT HANGAR PROJECT	
HOUSTON, TX	
DATE: 8/28/2020	DRAWN: PM
PROJECT #: S198890	CHECKED: XXX

DATE	DRWN	CHKD	DESCRIPTION

StormTech
Determination • Retention • Water Quality
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 860-525-8188 | 866-892-2694 | WWW.STORMTECH.COM

ADS
ADVANCED DRAINAGE SYSTEMS, INC.
 4640 TRUEMAN BLVD
 HILLIARD, OH 43026

80'
40'
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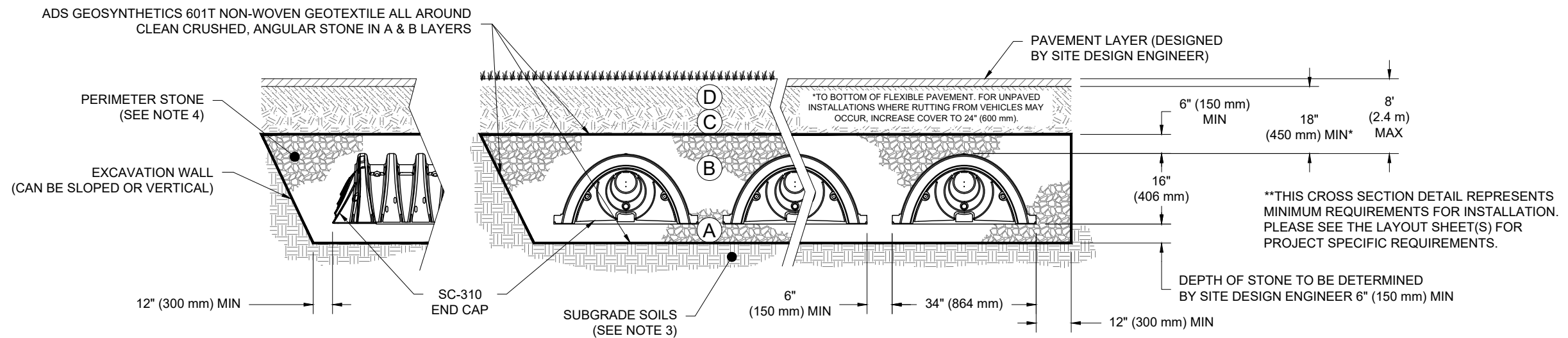
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ACCEPTABLE FILL MATERIALS: STORMTECH SC-310 CHAMBER SYSTEMS

MATERIAL LOCATION		DESCRIPTION	AASHTO MATERIAL CLASSIFICATIONS	COMPACTION / DENSITY REQUIREMENT
D	FINAL FILL: FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER.	ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS.	N/A	PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS.
C	INITIAL FILL: FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 18" (450 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER.	GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE. MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER.	AASHTO M145 ¹ A-1, A-2-4, A-3 OR AASHTO M43 ¹ 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	BEGIN COMPACTIONS AFTER 12" (300 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDITIONAL LAYERS IN 6" (150 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS. ROLLER GROSS VEHICLE WEIGHT NOT TO EXCEED 12,000 lbs (53 kN). DYNAMIC FORCE NOT TO EXCEED 20,000 lbs (89 kN).
B	EMBEDMENT STONE: FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43 ¹ 3, 357, 4, 467, 5, 56, 57	NO COMPACTION REQUIRED.
A	FOUNDATION STONE: FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43 ¹ 3, 357, 4, 467, 5, 56, 57	PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE. ^{2,3}

PLEASE NOTE:

- THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (AASHTO M43) STONE".
- STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 6" (150 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
- WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.
- ONCE LAYER 'C' IS PLACED, ANY SOIL/MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE THE MATERIAL REQUIREMENTS OF LAYER 'C' OR 'D' AT THE SITE DESIGN ENGINEER'S DISCRETION.**



NOTES:

- CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F2922 (POLETHYLENE) OR ASTM F2418-16a (POLYPROPYLENE), "STANDARD SPECIFICATION FOR CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
- SC-310 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
- THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
- PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
- REQUIREMENTS FOR HANDLING AND INSTALLATION:
 - TO MAINTAIN THE WIDTH OF CHAMBERS DURING SHIPPING AND HANDLING, CHAMBERS SHALL HAVE INTEGRAL, INTERLOCKING STACKING LUGS.
 - TO ENSURE A SECURE JOINT DURING INSTALLATION AND BACKFILL, THE HEIGHT OF THE CHAMBER JOINT SHALL NOT BE LESS THAN 2".
 - TO ENSURE THE INTEGRITY OF THE ARCH SHAPE DURING INSTALLATION, a) THE ARCH STIFFNESS CONSTANT AS DEFINED IN SECTION 6.2.8 OF ASTM F2922 SHALL BE GREATER THAN OR EQUAL TO 400 LBS/IN/IN. AND b) TO RESIST CHAMBER DEFORMATION DURING INSTALLATION AT ELEVATED TEMPERATURES (ABOVE 73° F / 23° C), CHAMBERS SHALL BE PRODUCED FROM REFLECTIVE GOLD OR YELLOW COLORS.

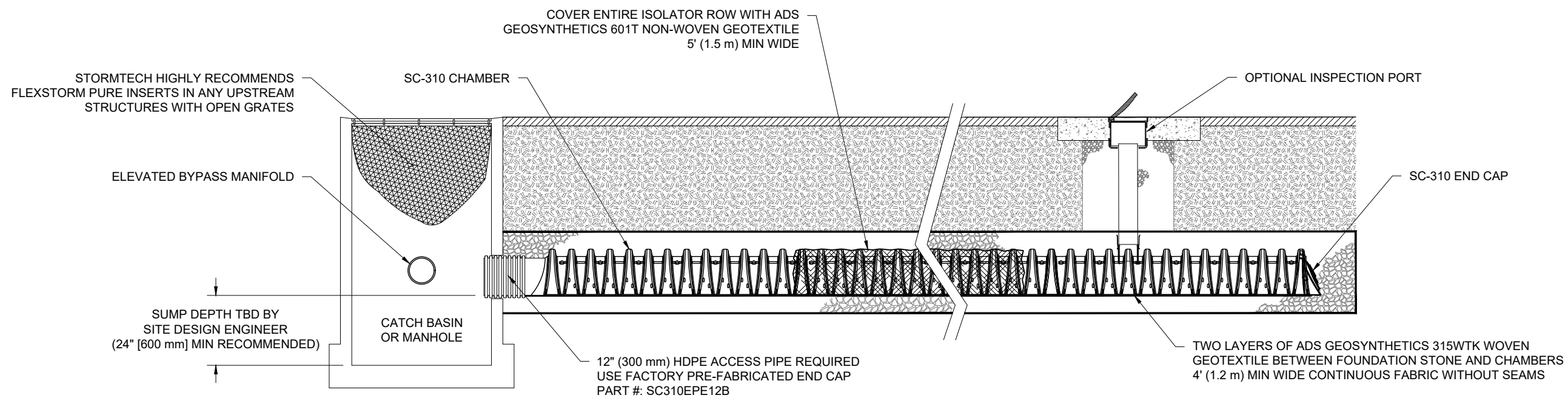
PROJECT: HOBBY AIRPORT ARFF
 LOCATION: HOUSTON, TX
 DATE: 8/28/2020
 DRAWN: PM
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ADS
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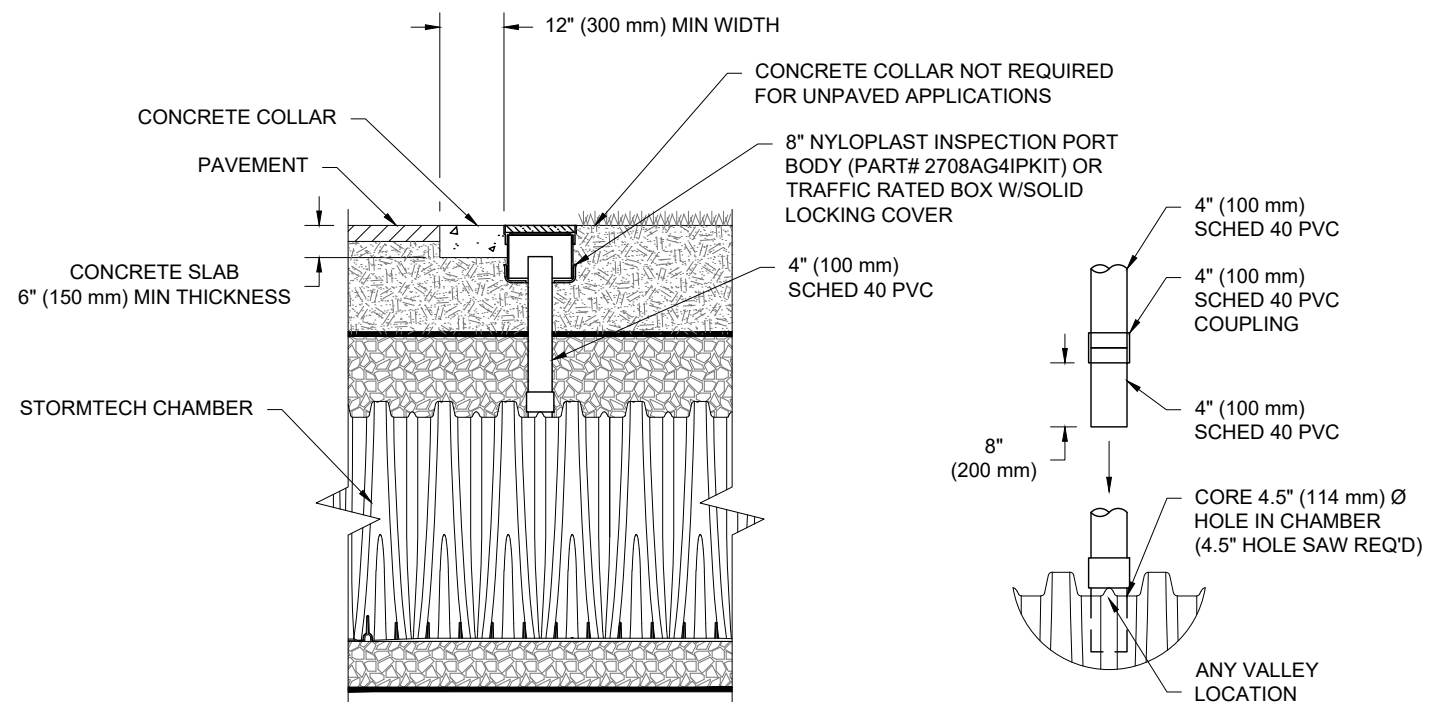
SC-310 ISOLATOR ROW DETAIL
NTS

INSPECTION & MAINTENANCE

- STEP 1) INSPECT ISOLATOR ROW FOR SEDIMENT
- A. INSPECTION PORTS (IF PRESENT)
 - A.1. REMOVE/OPEN LID ON NYLOPLAST INLINE DRAIN
 - A.2. REMOVE AND CLEAN FLEXSTORM FILTER IF INSTALLED
 - A.3. USING A FLASHLIGHT AND STADIA ROD, MEASURE DEPTH OF SEDIMENT AND RECORD ON MAINTENANCE LOG
 - A.4. LOWER A CAMERA INTO ISOLATOR ROW FOR VISUAL INSPECTION OF SEDIMENT LEVELS (OPTIONAL)
 - A.5. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.
 - B. ALL ISOLATOR ROWS
 - B.1. REMOVE COVER FROM STRUCTURE AT UPSTREAM END OF ISOLATOR ROW
 - B.2. USING A FLASHLIGHT, INSPECT DOWN THE ISOLATOR ROW THROUGH OUTLET PIPE
 - i) MIRRORS ON POLES OR CAMERAS MAY BE USED TO AVOID A CONFINED SPACE ENTRY
 - ii) FOLLOW OSHA REGULATIONS FOR CONFINED SPACE ENTRY IF ENTERING MANHOLE
 - B.3. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.
- STEP 2) CLEAN OUT ISOLATOR ROW USING THE JETVAC PROCESS
- A. A FIXED CULVERT CLEANING NOZZLE WITH REAR FACING SPREAD OF 45" (1.1 m) OR MORE IS PREFERRED
 - B. APPLY MULTIPLE PASSES OF JETVAC UNTIL BACKFLUSH WATER IS CLEAN
 - C. VACUUM STRUCTURE SUMP AS REQUIRED
- STEP 3) REPLACE ALL COVERS, GRATES, FILTERS, AND LIDS; RECORD OBSERVATIONS AND ACTIONS.
- STEP 4) INSPECT AND CLEAN BASINS AND MANHOLES UPSTREAM OF THE STORMTECH SYSTEM.

NOTES

1. INSPECT EVERY 6 MONTHS DURING THE FIRST YEAR OF OPERATION. ADJUST THE INSPECTION INTERVAL BASED ON PREVIOUS OBSERVATIONS OF SEDIMENT ACCUMULATION AND HIGH WATER ELEVATIONS.
2. CONDUCT JETTING AND VACTORING ANNUALLY OR WHEN INSPECTION SHOWS THAT MAINTENANCE IS NECESSARY.



- NOTES:
1. INSPECTION PORTS MAY BE CONNECTED THROUGH ANY CHAMBER CORRUGATION VALLEY.
 2. ALL SCHEDULE 40 FITTINGS TO BE SOLVENT CEMENTED (4" PVC NOT PROVIDED BY ADS).

4" PVC INSPECTION PORT DETAIL
NTS

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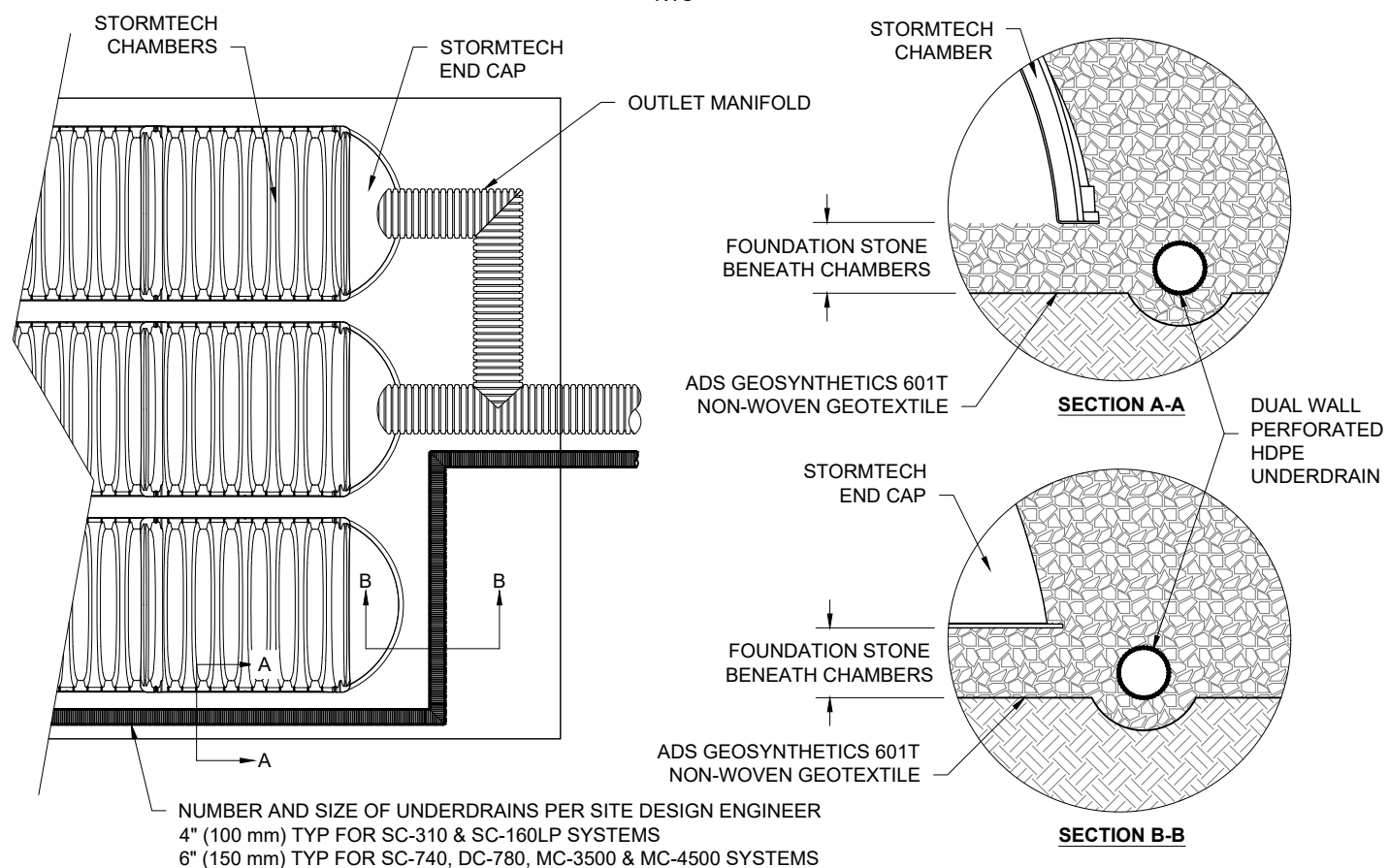
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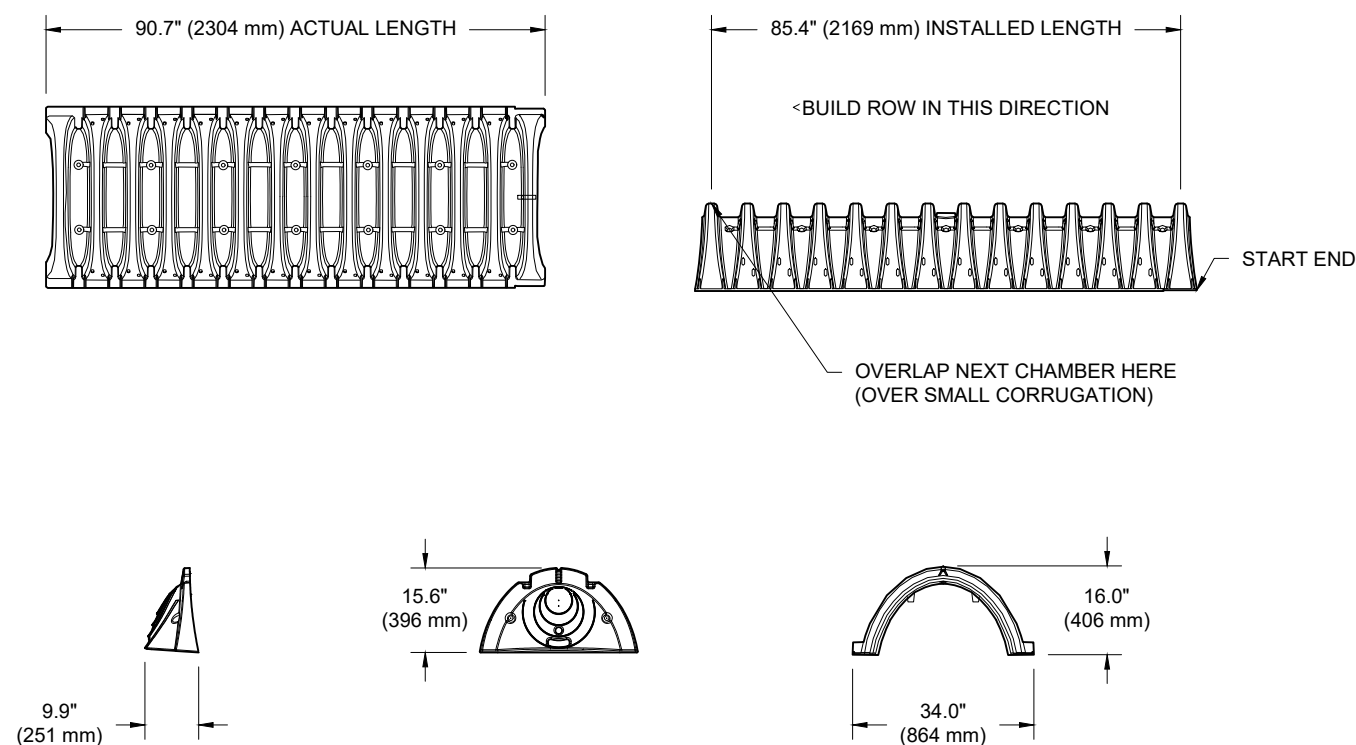
UNDERDRAIN DETAIL

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SC-310 TECHNICAL SPECIFICATION

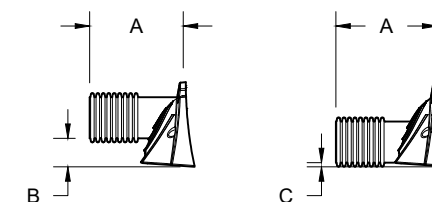
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NOMINAL CHAMBER SPECIFICATIONS

SIZE (W X H X INSTALLED LENGTH)	34.0" X 16.0" X 85.4"	(864 mm X 406 mm X 2169 mm)
CHAMBER STORAGE	14.7 CUBIC FEET	(0.42 m ³)
MINIMUM INSTALLED STORAGE*	31.0 CUBIC FEET	(0.88 m ³)
WEIGHT	35.0 lbs.	(16.8 kg)

*ASSUMES 6" (152 mm) ABOVE, BELOW, AND BETWEEN CHAMBERS



PRE-FAB STUBS AT BOTTOM OF END CAP FOR PART NUMBERS ENDING WITH "B"
PRE-FAB STUBS AT TOP OF END CAP FOR PART NUMBERS ENDING WITH "T"
PRE CORED END CAPS END WITH "PC"

PART #	STUB	A	B	C
SC310EPE06T / SC310EPE06TPC	6" (150 mm)	9.6" (244 mm)	5.8" (147 mm)	---
SC310EPE06B / SC310EPE06BPC			---	0.5" (13 mm)
SC310EPE08T / SC310EPE08TPC	8" (200 mm)	11.9" (302 mm)	3.5" (89 mm)	---
SC310EPE08B / SC310EPE08BPC			---	0.6" (15 mm)
SC310EPE10T / SC310EPE10TPC	10" (250 mm)	12.7" (323 mm)	1.4" (36 mm)	---
SC310EPE10B / SC310EPE10BPC			---	0.7" (18 mm)
SC310EPE12B	12" (300 mm)	13.5" (343 mm)	---	0.9" (23 mm)

ALL STUBS, EXCEPT FOR THE SC310EPE12B ARE PLACED AT BOTTOM OF END CAP SUCH THAT THE OUTSIDE DIAMETER OF THE STUB IS FLUSH WITH THE BOTTOM OF THE END CAP. FOR ADDITIONAL INFORMATION CONTACT STORMTECH AT 1-888-892-2694.

* FOR THE SC310EPE12B THE 12" (300 mm) STUB LIES BELOW THE BOTTOM OF THE END CAP APPROXIMATELY 0.25" (6 mm). BACKFILL MATERIAL SHOULD BE REMOVED FROM BELOW THE N-12 STUB SO THAT THE FITTING SITS LEVEL.

NOTE: ALL DIMENSIONS ARE NOMINAL

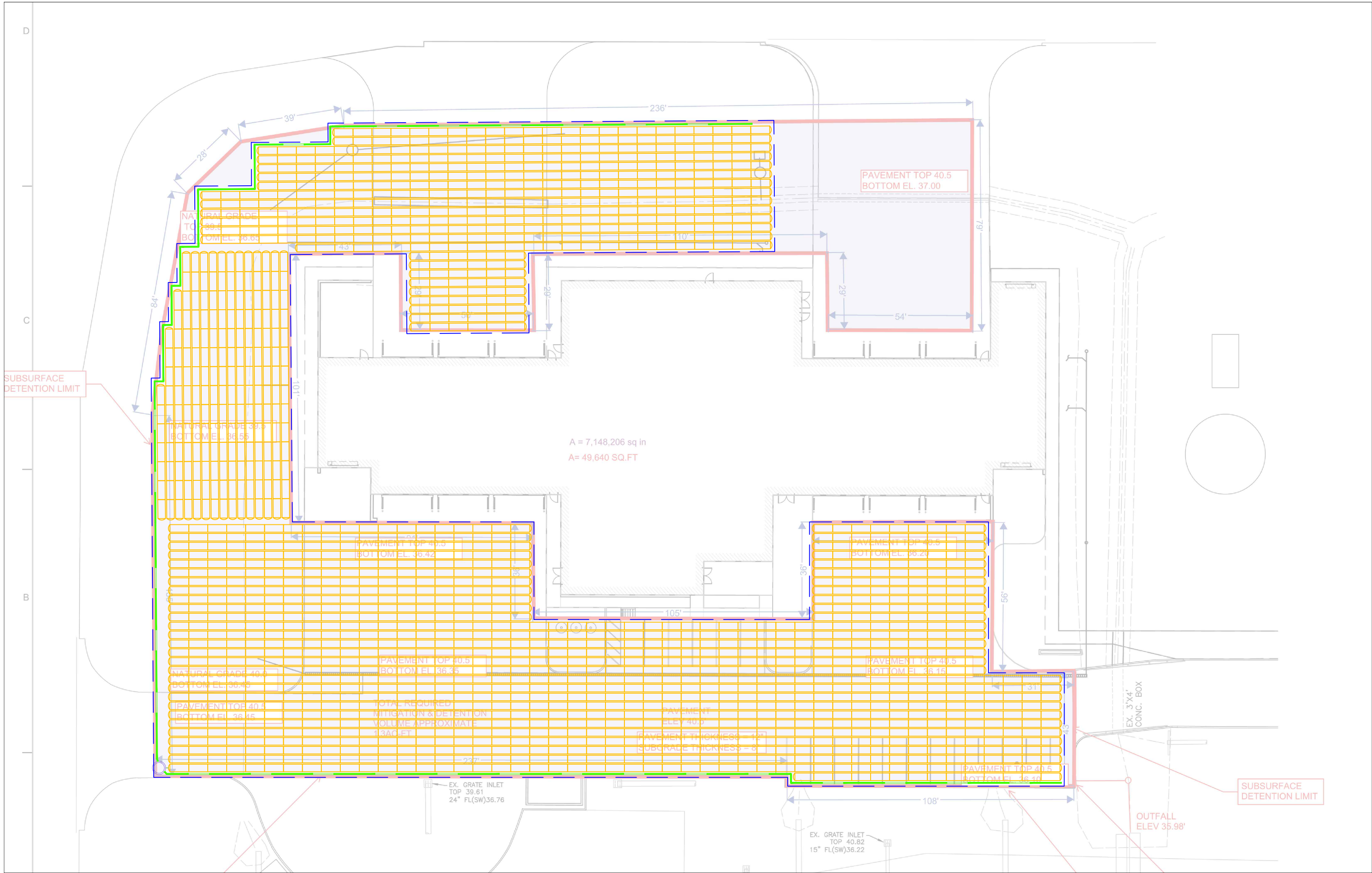
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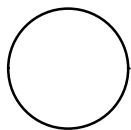
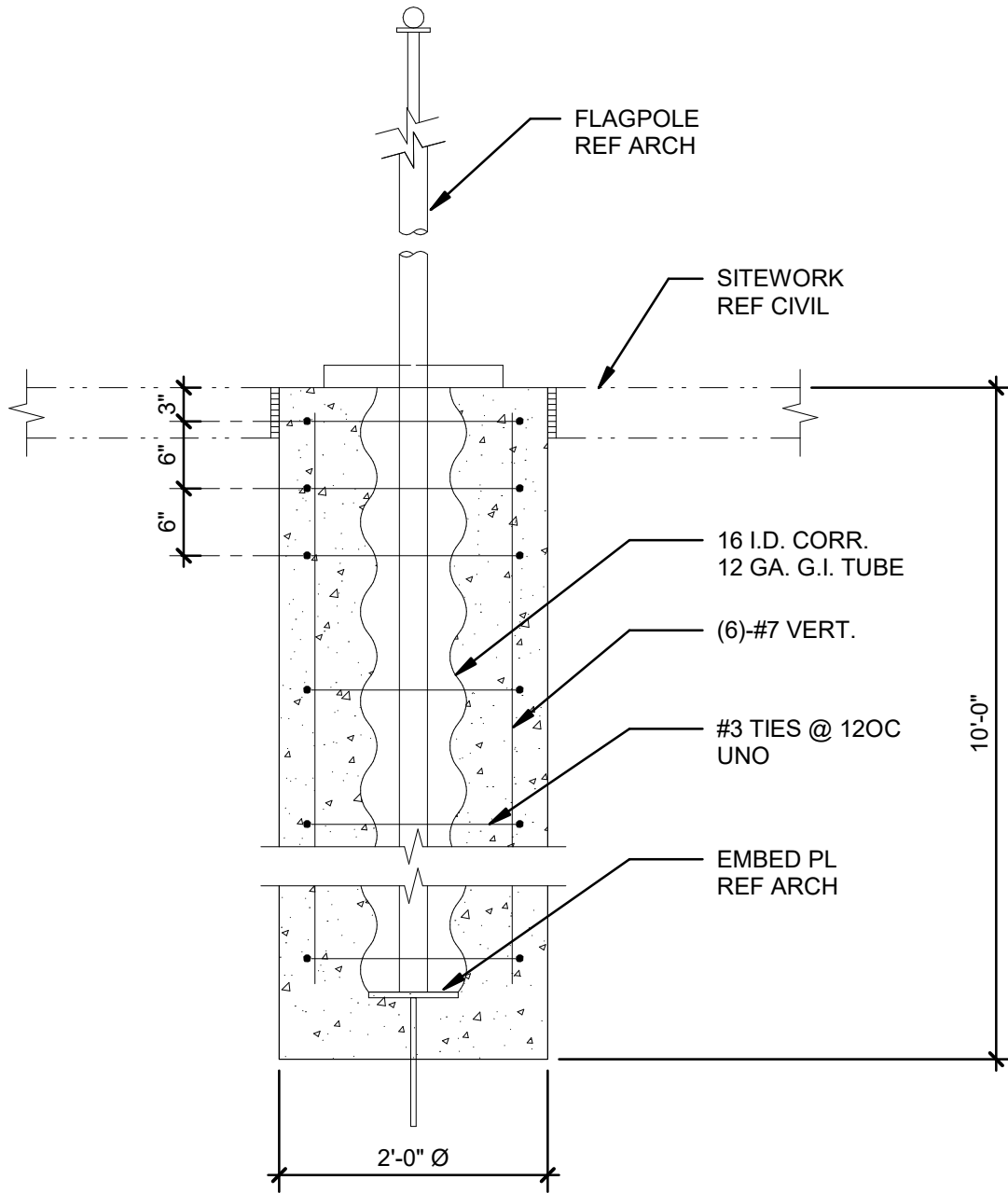
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FLAGPOLE DETAIL

SCALE:NO SCALE

HOU ARFF 81



LIMITED ASBESTOS SURVEY

**FIRE STATION 81 - ROOF
7990 PAUL KOONCE STREET
HOUSTON, TEXAS 77061**

Prepared For:

**FREESE AND NICHOLS, INC.
9601 MCALLISTER FREEWAY, SUITE 1008
SAN ANTONIO, TEXAS 77002**

JANUARY 13, 2021

LIMITED ASBESTOS SURVEY

Conducted At:

**FIRE STATION 81 - ROOF
7990 PAUL KOONCE STREET
HOUSTON, TEXAS 77061**


Prepared For:

**FREESE AND NICHOLS, INC.
9601 MCALLISTER FREEWAY, SUITE 1008
SAN ANTONIO, TEXAS 77002**


Prepared By:

**TERRA NOVA CONSULTING, INC.
9950 WESTPARK DRIVE, SUITE 446
HOUSTON, TEXAS 77063**

**LINA A. JAZI
PROJECT DIRECTOR**


Signature

**ROBERT L. VOORHIES
ASBESTOS CONSULTANT
(DSHS License #105524)**


Signature

JANUARY 13, 2021

ASBESTOS CONSULTANT AGENCY NO. 100473



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Houston, Texas 77063
Phone: 713-482-8787

E-Fax: 832-202-2524
info@ternov.com
www.ternov.com

January 13, 2021

Ms. Kara Marks
Freese and Nichols, Inc.
9601 McAllister Freeway Ste. 1008
San Antonio, TX 78216

**Re: Limited Asbestos Survey
Fire Station 81 - Roof
7990 Paul Koonce Street
Houston, Texas 77061
Project No. 210107002**

Dear Ms. Marks:

Terra Nova Consulting, Inc. is pleased to present the results of the Limited Asbestos Survey performed at Fire Station 81. This report includes the results of our findings from visual reconnaissance and laboratory analyses. The information from the field reconnaissance and analytical results was analyzed to arrive at the conclusions stated and the recommendations presented.

We appreciate the opportunity to be of service to you and look forward to working on future assignments. Should you have any question concerning this report or if we can assist you in any other matter, please feel free to contact us.

Sincerely,
Terra Nova Consulting, Inc.


Lina A. Jazi
Project Director

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APPENDIX A – SITE PHOTOGRAPHS

APPENDIX B – LAB REPORTS

1. INTRODUCTION

Terra Nova Consulting Inc. (Terra Nova) was retained by Freese and Nichols, Inc. to conduct a Limited Asbestos Survey of the roof of Fire Station 81 located at 7990 Paul Koonce Street, Harris County, Texas.

2. SCOPE OF SERVICES

This limited survey was performed to determine the potential presence of Asbestos-Containing Materials (ACMs) in the roof of Fire Station 81. On January 7, 2021, Ms. Francis Gonzalez (Texas Department of State Health Services License # 603002 performed the field survey and collected bulk samples of the suspect ACMs. Site photographs are included in *Appendix A*.

3. SAMPLING TECHNIQUES AND ANALYTICAL PROCEDURES

This section addresses the criteria necessary for identifying, evaluating and assessing suspect ACMs, as well as the analytical procedures used.

3.1. HOMOGENEOUS AREAS

Prior to collecting bulk samples of suspect ACM, distinct homogeneous sampling areas and specific sampling sites were defined based on building construction dates. A homogeneous sample area can be defined as a material that is similar in appearance, color, and generally having the same episode of installation as surrounding "like" material. Attempts were made in all cases to obtain representative samples of like materials as this is the most cost-effective method for determination of ACM. It should be assumed by the building owner, contractor, and the abatement contractors that the composition of like materials in a single homogeneous area is the same. Homogeneous areas sampled as part of this inspection include materials which have been identified by Terra Nova as suspect ACMs.

3.2. CONDITION ASSESSMENT

Asbestos is an airborne hazard. A condition assessment refers to the evaluation of a material's potential to release fibers into the air. Fibers may be released inadvertently by localized disturbance, as part of a material aging process, or when acted upon by other factors such as air movement, impact, and vibration. Assessing a material's potential for fiber release (therefore, its associated hazard risk) is accomplished by evaluating associated factors.

Friable / Non-Friable Materials: An ACM is a material that when dry, may be crumbled, pulverized, or reduced to powder by hand pressure, and includes non-friable material after such material

becomes damaged and when dry, it may be crumbled, pulverized, or reduced to powder by hand pressure (40 CFR 763.83).

Regulated Asbestos-Containing Materials (RACM) is defined as (a) friable ACM, (b) Category I non-friable ACM that has become friable, (c) Category I non-friable ACM that will be or has been subject to sanding, grinding, or abating, or (d) Category II non-friable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material during the course of the demolition or renovation operations.

ACM Condition Assessment: ACMs are assessed by field personnel to be in good, damaged, or significantly damaged condition. These subjective categories are described below:

- Good: ACMs in good condition are whole and complete. These materials are not expected to release airborne asbestos unless damaged or disturbed during renovation/repairs. In these cases, there is no immediate hazard of airborne asbestos and corrective action is usually not recommended.
- Damaged: ACMs in fair condition that are generally complete but shows some limited signs of damage or deterioration (i.e., <10% equally distributed or <25% locally damaged). These materials would be expected to release airborne asbestos when disturbed. In these cases, there is the potential hazard of airborne asbestos and the damaged material should be repaired or removed as soon as possible.
- Significantly Damaged: ACMs in poor condition that are generally severely damaged or deteriorated, usually with pieces missing (i.e., >10% equally distributed or >25% locally damaged). These materials would be expected to release airborne asbestos due to simple building motion or air currents. Since these materials are generally beyond repair and there exists an immediate hazard of airborne asbestos, these materials should be removed as soon as possible.

3.3. HAZARD ASSESSMENT

According to AHERA (October 30, 1986), verified friable or assumed ACMs uncovered in an inspection or reinspection of a facility shall be assessed in view of past, present, or future likelihood of disturbance and may include the following:

- Location of material present,
- Condition of material,
- Accessibility of the materials,
- Potential for disturbance of the material,
- Known or suspected causes of damage (i.e., air erosion, vandalism, service or repair, vibration, and water),

- Preventive measures which might eliminate the likelihood of undamaged ACM from becoming significantly damaged,
- Actions to be taken to protect human health.

The asbestos hazard categories as defined by the City of Houston are divided into the following categories:

Hazard Category	Response Action
A: No asbestos found	No asbestos found
A-1: Asbestos Abated	Once identified, asbestos-containing materials have been abated
B-1: Asbestos Present	Contains 1% asbestos, or less, not regulated by DSHS
B-2: Asbestos Present	Adequately enclosed
B-3: Asbestos Present	Adequately encapsulated
C-1: Asbestos Present	Serious health hazard, as defined by EPA, abatement should be a top priority
C-2: Asbestos Present	Health hazard, as defined by EPA, abatement should be planned
C-3: Asbestos Present	No action necessary unless renovation, remodeling, or demolition is planned

The hazard assessments given for various materials are general, based on the average conditions observed during the survey. However, because of various limiting factors in performing a survey, these assessments do not attempt to inventory and rate every hazardous circumstance throughout the survey area.

Additionally, the hazard associated with any material may become more severe over time. Buildings are dynamic, constantly changing facilities. Each change has the potential to contribute to an increased health hazard.

3.4. SAMPLES COLLECTION AND ANALYTICAL PROCEDURES

A total of thirty (30) samples were collected from the suspect ACMs. The samples were submitted to A&B Labs in Houston, Texas, to be analyzed utilizing the Environmental Protection Agency's Polarized Light Microscopy (PLM) Method for the Detection of Asbestos in Bulk Insulation Samples (EPA 600/R-93/116) or 40 CFR, Part 763, Subpart F as appropriate. Components of non-homogenous or layered materials are analyzed separately and reported individually if asbestos is found in one or more layers or components. A&B Labs is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP), participates in the NVLAP and AIHA Bulk Asbestos Sample Quality Assurance Programs, and is licensed to analyze bulk asbestos samples

collected in the State of Texas (TDSHS #300080).

4. ANALYTICAL AND HAZARD ASSESSMENT RESULTS

Asbestos was not detected in any of the samples collected and analyzed. Laboratory reports are included in *Appendix B*.

5. CONCLUSIONS AND RECOMMENDATIONS

Based on the analytical results, the sampled material is classified under the City of Houston's hazard categorization standard as A: No asbestos found No asbestos found.

6. GENERAL PROVISIONS

The removal or disturbance of any ACM is regulated under the Occupational Safety and Health Administration (OSHA), the Environmental Protection Agency (EPA), National Emission Standards for Hazardous Air Pollutants (NESHAP); and the Texas Department of State Health Services' (DSHS) Texas Asbestos Health Protection Rules (TAHPR) and must be performed with the proper engineering and regulatory controls by a licensed asbestos abatement contractor and consultant. In most cases, a licensed asbestos consultant is required to prepare project specific work procedures and perform on-site project monitoring (inclusive of the final work area visual inspection and air clearance). This provides critical documentation for the building owner.

EPA has not prohibited the manufacture of non-friable asbestos-containing materials, such as vinyl floorings, mastics, roofing materials, and joint compound. Materials arriving from other countries can contain asbestos.

In addition, House Bill 1927 and the TDSHS' TAHPR prohibit the installation of asbestos-containing materials in public and commercial buildings, unless there is not an alternative material or part. Material Safety Data Sheets (MSDS) must be obtained for building materials or replacement parts. As a result, any future replacement materials should be checked for the presence of asbestos or certification from a licensed engineer or architect should be obtained stating that the MSDS have been reviewed and in their professional opinion all parts of the building affected by the planned renovation or demolition do not contain asbestos.

7. LIMITATIONS

This work product was performed consistent with standards of care and diligence normally practiced by recognized environmental consulting firms in performing services of a similar nature in this region.

This survey was limited to the roof as requested by the client. Un-sampled asbestos-containing pipes or construction materials may be located above the ceiling, in interior and exterior materials, within walls, ceiling cavities, underneath ceiling tiles, below flooring or grade, above ceiling tiles, and in other non-accessible areas. Therefore, if any suspect material, not sampled during this survey, is encountered during any building activities, it should be sampled and tested for possible asbestos content by qualified personnel prior to the continuation of these activities. Precaution should be used in relation to these un-sampled materials until proper sampling and analyses have determined their asbestos content. The condition of the ACMs may change gradually or suddenly, depending upon use, maintenance, or accident.

Terra Nova relied on the results of the analytical testing performed by A&B Labs, an independent laboratory in Houston, Texas. Terra Nova does not guarantee or warranty the analytical results provided by A&B Labs but assumes that the results are true and accurate.

The conclusions and recommendations in this report are professional opinions based solely upon visual observations of the site, at the time of our investigation, and the results of laboratory analyses. These opinions describe only the reasonably foreseeable conditions present at the time of our investigation in areas that were observed. They cannot necessarily apply to site conditions that Terra Nova is not aware of and has not had the opportunity to evaluate. Terra Nova and its representatives do not warrant against future changes in operations or conditions, nor do they warrant conditions present of a type or at a location not addressed in this study.

Terra Nova cannot act as insurers, and no expressed or implied representation or warrant is included or intended in our report except that our work was performed, within the limits prescribed by our client, with the customary thoroughness and competence of our profession.

This report does not constitute an appraisal of value or legal opinion and Terra Nova makes no representations or warranties of the fitness of the property for any specific use or value. Terra Nova assumes no responsibility for the client's, or a third party's, misinterpretation or improper use of this report.

Terra Nova shall not be liable for any special, consequential, or exemplary damages resulting in whole or in part, from the Client's use of this report. Liability on the part of Terra Nova to any impacted third party is limited to the monetary value paid for this report.

January 13, 2021
Fire Station 81 - Roof
7990 Paul Koonce Street
Houston, Texas 77061
Project No. 210107002

APPENDIX A
SITE PHOTOGRAPHS



January 13, 2021
Fire Station 81 - Roof
7990 Paul Koonce Street
Houston, Texas 77061
Project No. 210107002

APPENDIX B
LAB REPORTS

LABORATORY ANALYSIS REPORT



A & B Environmental Services, Inc.
 10100 East Freeway, Suite 100
 Houston, Texas 77029

A&B Job ID: 21010361

Report Date : 1/12/2021

Total No of Pages : 11

NVLAP Lab Code : 101793-0 TDSHS LICENSE # : 300080

ProjectName : 210107002 / Fire Station 81 (Hobby)
 7990 Paul B. Koonce, Houston, TX

Client : Terra Nova Consulting
 Contact : Lina Jazi
 Address : 9950 Westpark Dr., Ste. 446
 Houston, Texas 77063

P.O.#. :
 Sample Collected By : Francis Gonzalez
 Date Received : 01/07/2021
 Sample Received By : AArnett

Analysis by EPA Method 600/R-93/116 or 40 CFR, Part 763, Subpart F as appropriate. Components of non-homogenous or layered materials are analyzed separately and reported individually if asbestos is found in one or more layers or components. Analysis of vinyl floor tile and other resinously bound materials using these methods may yield false negative results. The Client may consider confirmation of negative results on these materials by TEM analysis. Fiber quantification is based on calibrated visual estimation. State regulations prohibit classifying asbestos containing materials as having 1% or less unless verified by point count. The Client should consider additional quantification by point count for friable materials containing 1-3% asbestos. These results pertain only to the items tested. This report may not be reproduced, except in full, without the written permission of A & B Environmental. The report must not be used by the Client to claim product endorsement by NVLAP or any agency of the U.S. Government. All samples are assumed to be in acceptable condition unless otherwise noted.

A & B Labs has analyzed the following samples . . .

Your Sample ID	Asbestos Detected	Result	A&B Job Sample ID
01	No		21010361.01.A
02	No		21010361.02.A
03	No		21010361.03.A
04	No		21010361.04.A
05	No		21010361.05.A
06	No		21010361.06.A
07	No		21010361.07.A
08	No		21010361.08.A
09	No		21010361.09.A
10	No		21010361.10.A
11	No		21010361.11.A
12	No		21010361.12.A
13	No		21010361.13.A
14	No		21010361.14.A
15	No		21010361.15.A
16	No		21010361.16.A
17	No		21010361.17.A
18	No		21010361.18.A
19	No		21010361.19.A
20	No		21010361.20.A
21	No		21010361.21.A
22	No		21010361.22.A

LABORATORY ANALYSIS REPORT



A & B Environmental Services, Inc.
10100 East Freeway, Suite 100
Houston, Texas 77029

A&B Job ID: 21010361

Report Date : 1/12/2021

Total No of Pages : 11

NVLAP Lab Code : 101793-0 TDSHS LICENSE # : 300080

ProjectName : 210107002 / Fire Station 81 (Hobby)
7990 Paul B. Koonce, Houston, TX

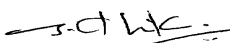
Client : Terra Nova Consulting
Contact : Lina Jazi
Address : 9950 Westpark Dr., Ste. 446
Houston, Texas 77063

P.O.#. :
Sample Collected By : Francis Gonzalez
Date Received : 01/07/2021
Sample Received By : AArnett

A & B Labs has analyzed the following samples . . .

Your Sample ID	Asbestos Detected	Result	A&B Job Sample ID
23	No		21010361.23.A
24	No		21010361.24.A
25	No		21010361.25.A
26	No		21010361.26.A
27	No		21010361.27.A
28	No		21010361.28.A
29	No		21010361.29.A
30	No		21010361.30.A

Thank you for choosing A & B Labs.


Approved By: Senthilkumar Sevukan
Title: Assistant Lab Manager

Analyst: 

TEST REPORT FOR BULK ASBESTOS BY PLM



A&B Job ID 21010361

Date : 01/12/2021

Client Name: Terra Nova Consulting
 Project 210107002 / Fire Station 81 (Hobby) 7990
 Name: Paul B. Koonce, Houston, TX

Date Received: 01/07/2021
 Date Analyzed: 01/11/2021
 Analyst Initial: HA

<i>A&B Sample ID</i> <i>Client Sample ID</i>	<i>Sample Description</i>	<i>Asbestos Detected</i>	<i>Asbestos Fibers</i>	<i>Other Fibers</i>	<i>Non - Fibrous Material</i>
21010361.01 21010361.01.A 01 Layer % of Total :100%	Mastic Granular/Tar Homogeneous Black/Silver	No		GlassFibers 1-10%	Binder MetalFoil Silica Tar
21010361.02 21010361.02.A 02 Layer % of Total :100%	Mastic Granular/Tar Homogeneous Black/Silver	No		GlassFibers 1-10%	Binder MetalFoil Silica Tar
21010361.03 21010361.03.A 03 Layer % of Total :100%	Mastic Granular/Tar Homogeneous Black/Silver	No		GlassFibers 1-10%	Binder MetalFoil Silica Tar
21010361.04 21010361.04.A 04 Layer % of Total :100%	Roofing Fibrous/Granular/Tar Homogeneous Black/Gray	No		Cellulose 1-10% GlassFibers 11-50%	Binder Glue Silica Tar
21010361.05 21010361.05.A 05 Layer % of Total :100%	Roofing Fibrous/Granular/Tar Homogeneous Black/Gray	No		Cellulose 1-10% GlassFibers 11-50%	Binder Glue Silica Tar
21010361.06 21010361.06.A 06 Layer % of Total :100%	Roofing Fibrous/Granular/Tar Homogeneous Black/Gray	No		Cellulose 1-10% GlassFibers 11-50%	Binder Glue Silica Tar
21010361.07 21010361.07.A 07 Layer % of Total :100%	Sealant Granular/Tar Homogeneous Black	No		Cellulose 1-10%	Binder Minrl Frags Tar

TEST REPORT FOR BULK ASBESTOS BY PLM



A&B Job ID 21010361

Date : 01/12/2021

Client Name: Terra Nova Consulting
 Project 210107002 / Fire Station 81 (Hobby) 7990
 Name: Paul B. Koonce, Houston, TX

Date Received: 01/07/2021
 Date Analyzed: 01/11/2021
 Analyst Initial: HA

<i>A&B Sample ID</i> <i>Client Sample ID</i>	<i>Sample Description</i>	<i>Asbestos Detected</i>	<i>Asbestos Fibers</i>	<i>Other Fibers</i>	<i>Non - Fibrous Material</i>
21010361.08 21010361.08.A 08 Layer % of Total :100%	Sealant Granular/Tar Homogeneous Black	No		Cellulose 1-10%	Binder Minrl Frags Tar
21010361.09 21010361.09.A 09 Layer % of Total :100%	Sealant Granular/Tar Homogeneous Black	No		Cellulose 1-10%	Binder Minrl Frags Tar
21010361.10 21010361.10.A 10 Layer % of Total :100%	Granular & Fibrous Material Fibrous/Granular/Vinyl Homogeneous Black/White	No		Synthetic 11-50%	Binder Glue Minrl Frags Vinyl
21010361.11 21010361.11.A 11 Layer % of Total :100%	Granular & Fibrous Material Fibrous/Granular/Vinyl Homogeneous Black/White	No		Synthetic 11-50%	Binder Glue Minrl Frags Vinyl
21010361.12 21010361.12.A 12 Layer % of Total :100%	Granular & Fibrous Material Fibrous/Granular/Vinyl Homogeneous Black/White	No		Synthetic 11-50%	Binder Glue Minrl Frags Vinyl
21010361.13 21010361.13.A 13 Layer % of Total :100%	Granular & Fibrous Material Fibrous/Granular/Vinyl Homogeneous Gray/White	No		Cellulose 11-50% Synthetic 11-50%	Binder Glue Minrl Frags Vinyl
21010361.14 21010361.14.A 14 Layer % of Total :100%	Granular & Fibrous Material Fibrous/Granular/Vinyl Homogeneous Gray/White	No		Cellulose 11-50% Synthetic 11-50%	Binder Glue Minrl Frags Vinyl

TEST REPORT FOR BULK ASBESTOS BY PLM



A&B Job ID 21010361

Date : 01/12/2021

Client Name: Terra Nova Consulting
 Project 210107002 / Fire Station 81 (Hobby) 7990
 Name: Paul B. Koonce, Houston, TX

Date Received: 01/07/2021
 Date Analyzed: 01/11/2021
 Analyst Initial: HA

<i>A&B Sample ID</i> <i>Client Sample ID</i>	<i>Sample Description</i>	<i>Asbestos Detected</i>	<i>Asbestos Fibers</i>	<i>Other Fibers</i>	<i>Non - Fibrous Material</i>
21010361.15 21010361.15.A 15 Layer % of Total :100%	Granular & Fibrous Material Fibrous/Granular/Vinyl Homogeneous Gray/White	No		Cellulose 11-50% Synthetic 11-50%	Binder Glue Minrl Frags Vinyl
21010361.16 21010361.16.A 16 Layer % of Total :100%	Sealant Granular/Tar/Vinyl Homogeneous Black/White	No		Cellulose 1-10%	Binder Minrl Frags Tar Vinyl
21010361.17 21010361.17.A 17 Layer % of Total :100%	Caulk Granular/Vinyl Homogeneous Gray/Tan	No		Cellulose 1-10%	Binder Glue Minrl Frags Vinyl
21010361.18 21010361.18.A 18 Layer % of Total :100%	Caulk Granular/Tar/Vinyl Homogeneous Black/White	No		Cellulose 1-10%	Binder Minrl Frags Tar Vinyl
21010361.19 21010361.19.A 19 Layer % of Total :100%	Caulk Granular/Vinyl Homogeneous Black/Brown	No		Cellulose 1-10%	Binder Glue Minrl Frags Vinyl
21010361.20 21010361.20.A 20 Layer % of Total :100%	Caulk Granular/Vinyl Homogeneous Brown	No		Cellulose 1-10%	Binder Glue Minrl Frags Vinyl
21010361.21 21010361.21.A 21 Layer % of Total :100%	Caulk Granular/Vinyl Homogeneous Brown	No		Cellulose 1-10%	Binder Glue Minrl Frags Vinyl

TEST REPORT FOR BULK ASBESTOS BY PLM



A&B Job ID 21010361

Date : 01/12/2021

Client Name: Terra Nova Consulting
 Project 210107002 / Fire Station 81 (Hobby) 7990
 Name: Paul B. Koonce, Houston, TX

Date Received: 01/07/2021
 Date Analyzed: 01/11/2021
 Analyst Initial: HA

<i>A&B Sample ID</i> <i>Client Sample ID</i>	<i>Sample Description</i>	<i>Asbestos Detected</i>	<i>Asbestos Fibers</i>	<i>Other Fibers</i>	<i>Non - Fibrous Material</i>
21010361.22 21010361.22.A 22 Layer % of Total :100%	Glazing Granular/Vinyl Homogeneous Gray/Tan	No		Cellulose 1-10%	Binder Glue Minrl Frags Vinyl
21010361.23 21010361.23.A 23 Layer % of Total :100%	Glazing Granular/Vinyl Homogeneous Gray/Tan	No		Cellulose 1-10%	Binder Glue Minrl Frags Vinyl
21010361.24 21010361.24.A 24 Layer % of Total :100%	Glazing Granular/Vinyl Homogeneous Gray/Tan	No		Cellulose 1-10%	Binder Glue Minrl Frags Vinyl
21010361.25 21010361.25.A 25 Layer % of Total :100%	Roof Material Fibrous/Granular/Tar Homogeneous Black/White	No		GlassFibers 11-50%	Binder Paint Silica Tar
21010361.26 21010361.26.A 26 Layer % of Total :100%	Roof Material Fibrous/Granular/Tar Homogeneous Black/White	No		GlassFibers 11-50%	Binder Paint Silica Tar
21010361.27 21010361.27.A 27 Layer % of Total :100%	Roof Material Fibrous/Granular/Tar Homogeneous Black/White	No		GlassFibers 11-50%	Binder Paint Silica Tar
21010361.28 21010361.28.A 28 Layer % of Total :100%	Roof Shingle Fibrous/Granular/Tar Homogeneous Black/Gray	No		GlassFibers 11-50%	Binder Paint Silica Tar

TEST REPORT FOR BULK ASBESTOS BY PLM



A&B Job ID 21010361

Date : 01/12/2021

Client Name: Terra Nova Consulting
 Project 210107002 / Fire Station 81 (Hobby) 7990
 Name: Paul B. Koonce, Houston, TX

Date Received: 01/07/2021
 Date Analyzed: 01/11/2021
 Analyst Initial: HA

<i>A&B Sample ID</i> <i>Client Sample ID</i>	<i>Sample Description</i>	<i>Asbestos Detected</i>	<i>Asbestos Fibers</i>	<i>Other Fibers</i>	<i>Non - Fibrous Material</i>
21010361.29	Roof Shingle	No		GlassFibers 11-50%	Binder
21010361.29.A	Fibrous/Granular/Tar				Paint
29	Homogeneous				Silica
	Black/Gray				Tar
Layer % of Total :100%					
21010361.30	Roof Shingle	No		GlassFibers 11-50%	Binder
21010361.30.A	Fibrous/Granular/Tar				Paint
30	Homogeneous				Silica
	Black/Gray				Tar
Layer % of Total :100%					



Sample Condition Checklist

A&B JobID : 21010361	Date Received : 01/07/2021	Time Received : 2:24PM
Client Name : Terra Nova Consulting		
Temperature : 21.9°C	Sample pH : n/a	
Thermometer ID : 102002320	pH Paper ID : n/a	
Perservative :		

	Check Points	Yes	No	N/A																								
1.	Cooler seal present and signed.			X																								
2.	Sample(s) in a cooler.		X																									
3.	If yes, ice in cooler.			X																								
4.	Sample(s) received with chain-of-custody.	X																										
5.	C-O-C signed and dated.	X																										
6.	Sample(s) received with signed sample custody seal.		X																									
7.	Sample containers arrived intact. (If no comment).	X																										
8.	<table style="width: 100%; border: none;"> <tr> <td style="width: 10%;">Matrix</td> <td style="width: 10%;">Water</td> <td style="width: 10%;">Soil</td> <td style="width: 10%;">Liquid</td> <td style="width: 10%;">Sludge</td> <td style="width: 10%;">Solid</td> <td style="width: 10%;">Cassette</td> <td style="width: 10%;">Tube</td> <td style="width: 10%;">Bulk</td> <td style="width: 10%;">Badge</td> <td style="width: 10%;">Food</td> <td style="width: 10%;">Other</td> </tr> <tr> <td>:</td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input checked="" type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> </table>	Matrix	Water	Soil	Liquid	Sludge	Solid	Cassette	Tube	Bulk	Badge	Food	Other	:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
Matrix	Water	Soil	Liquid	Sludge	Solid	Cassette	Tube	Bulk	Badge	Food	Other																	
:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																	
9.	Sample(s) were received in appropriate container(s).	X																										
10.	Sample(s) were received with proper preservative			X																								
11.	All samples were logged or labeled.	X																										
12.	Sample ID labels match C-O-C ID's	X																										
13.	Bottle count on C-O-C matches bottles found.	X																										
14.	Sample volume is sufficient for analyses requested.	X																										
15.	Samples were received within the hold time.	X																										
16.	VOA vials completely filled.			X																								
17.	Sample accepted.	X																										
18.	Has client been contacted about sub-out			X																								

Comments : Include actions taken to resolve discrepancies/problem:

Received by : AArnett

Check in by/date : AOballe / 01/07/2021



10100 East Freeway (I-10)
Houston, TX 77029
713-453-6060
1-877-478-6060 Toll Free
713-453-6091 Fax
info@ablab.com
www.ablab.com

1. REPORT TO:
Company: TELLANOVA CONSULTING
Address: 9950 WESTPARK
STE. 446 HOUSTON, TX
Attn: LINA JAZI
Phone: 713-482-8787
email: info@tellnova.com

2. INVOICE TO:
SAME

3. PO #
4. Turnaround Time- Business Days
 1 Day * 5 Days *
 2 Days * 7 Days-Standard
 3 Days * Other _____
* Surcharge Applies
Day Zero is the day sample is received.
Report due at 5pm on due day.

A&B JOB ID

5. Project # 210107002

6. Project Name / Location: FIRE STATION 81 (HOBBY)
7990 PAUL B. KRONE HOUSTON, TX (ROOF ONLY)

7. Sampler's Name & Company: FRANCIS GONZALEZ / TELLANOVA
Sampler's Signature & Date: [Signature] 1-7-21

8. Sample ID & Description: Lab Use Only
9. Sampling: * Required Information, no flow rate needed for badges

Sample Number/Employee or Location*	Lab ID	Date*	Time On*	Time Off*	Flow Rate L/M*	Total Minutes	Sample Volume Liters	Number of containers	Particle Size Range					
01-30	01A-	1/2/21							2 AM					
SEE ATTACHED DATA SHEETS	30A													

* Job ID: 21010361

 TAT: 3 Days PM: Scarpenter

12. Media Type
Examples
MCE Cassette/PVC
Cassette/Glass Fiber
Mold: AirCel /Allergenco
OVM Badge: 3500 / 3520/
UME-100
Sorbent Tube: Charcoal /
Silica Gel/ XAD

13. RELINQUISHED BY		DATE	TIME	14. RECEIVED BY		DATE	TIME	KNOWN HAZARDS / COMMENTS
1)	[Signature]	1/2/21	1424	2)	[Signature]	1-7-21	1424	
								21.9°C

BILL OF LADING/TRACKING # _____ Intact? Y N
Initials: AA 102002320

A&B CANNOT ACCEPT VERBAL CHANGES. PLEASE FAX WRITTEN CHANGES TO 713-453-6091 OR EMAIL THE NEW COC TO YOUR PROJECT MANAGER.

Samples will be disposed of after 30 days. A&B reserves the right to return samples.



* Job ID:21010361



9950 Westpark Drive, Suite 446
Houston, Texas 77063
Tel: (713) 482-8787
Fax: (832) 202-2524
E-Mail: info@ternov.com

BULK MATERIAL SAMPLE COLLECTION FORM - ASBESTOS

Project No.	210107002	Date:	1-7-21
Project Name:	FIRE STATION 81 (Hobby)	Type of Analysis:	PLM
Location:	7990 PAUL B. KATZ HOUSTON, TX	Inspector:	Francis Gonzalez
Client:	HAS	DSHS License No.:	403002

H.A.=Homogenous Area; Condition: G=Good, D=Damaged, S=Significantly Damaged; Amount: SF=Square Feet, LF=Linear Feet

Sample No.	Sample Location	Sample Description	Condition (G, D, S)	Friable (Y/N)	H.A. Location	Approx. SF/LF
01	W. @ ROOF #1 (NE BLDG.)	Aluminum w/ Blk Mastic Roof Flashing	G	N	NE BLDG.	
02	E " " "	↓ ↓	↓	↓		
03	S " " "	↓ ↓	↓	↓		
04	N ROOFING @ NE Bldg.	Gray w/ Blk. TAP Roof Sample	G	N		
05	CR	↓ ↓	↓	↓		
06	S ↓ ↓	↓ ↓	↓	↓		
07	VENT @ NE Corner	Black TAP MATERIAL	G	N		
08	↓ ↓	↓ ↓	↓	↓		
09	VENT @ SW Corner	↓ ↓	↓	↓		
10	N @ WEST BLDG. LIVING	WHITE ROOF FLASHING w/ COVER	G	N	WEST BLDG. (LIVING)	
11	SE @ QUARTERS	↓ ↓	↓	↓	QUARTERS	
12	S ↓ ↓	↓ ↓	↓	↓		
13	N @ WEST BLDG. LIVING	WHITE Cloth ROOFING MATL.	G	N		
14	CR. @ QUARTERS	↓ ↓	↓	↓		
15	S ↓ ↓	↓ ↓	↓	↓		
16	NW @ W. BLDG. (LIVING QUARTERS)	WHITE/BLK. TAP ON VENTS	G	N		



* Job ID:21010361



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Houston, Texas 77063
Tel: (713) 482-8787
Fax: (832) 202-2524
E-Mail: info@ternov.com

BULK MATERIAL SAMPLE COLLECTION FORM - ASBESTOS

Project No.	210107002	Date:	1-7-21
Project Name:	FIRE STATION B1 (HOBBY)	Type of Analysis:	PLM
Location:	7990 PAUL B. KOONE - HOUSTON, TX	Inspector:	Francis Gonzalez
Client:	HAS	DSHS License No.:	603007

H.A.=Homogenous Area; Condition: G=Good, D=Damaged, S=Significantly Damaged; Amount: SF=Square Feet, LF=Linear Feet

Sample No.	Sample Location	Sample Description	Condition (G, D, S)	Friable (Y/N)	H.A. Location	Approx. SF/LF
17	S @ W. BLDG.	WHITE/BLK. TRM/CAULK @ VENTS	G	N	W BLDG (LIVING	
18	SE @ W. BLDG.	↓ ↓	↓	↓	↓ ↓ QUARTERS)	
19	N @ NE BLDG.	BROWN JOINT GLAZING @ NW BLDG.	G	N	Perimeter BROWN CAP	
20						
21	S ↓ ↓ ↓	↓ ↓	↓	↓	↓ ↓	
22	N @ SE BLDG. CANOPY	WHITE GLAZING @ FLASHING	G	N	SE BLDG. CANOPY	
23	ME ↓ ↓	↓ ↓	↓	↓		
24	NW ↓ ↓	↓ ↓	↓	↓		
25	NE @ CANOPY BLDG.	Gray Roof FLASHING	G	N		
26	N ↓ ↓	↓ ↓	↓	↓		
27	NW ↓ ↓	↓ ↓	↓	↓		
28	N. @ CANOPY BLDG.	Gray Roof Comp. MATL.	↓	↓		
29	CR. ↓ ↓	↓ ↓	↓	↓		
30	S. ↓ ↓	↓ ↓	↓	↓		



ASBESTOS SURVEY

EFI Global File No.: 029.01934



**HOBBY AIRPORT
HOBBY – FIRE STATION NO. 81
7990 PAUL KOONCE STREET
HOUSTON, TEXAS**



April 22, 2020



Prepared For:



City of Houston



**Attn: Mr. Gabriel Mussio
900 Bagby, Floor 2
Houston, Texas 77002**



2000 South Dairy Ashford, Suite 600
Houston, Texas 77077

Project No. 029.01934
April 22, 2020

Mr. Gabriel Mussio
City of Houston
900 Bagby, Floor 2
Houston, Texas 77002

via email: Gabriel.mussio@houstontx.com

**Subject: Asbestos Survey
Hobby – Fire Station No. 81
7990 Paul Koonce Street
Houston, Texas**

Dear Mr. Mussio:

This report presents the results of our Asbestos Survey conducted at the Hobby Airport, Fire Station No. 81 located at 7990 Paul Koonce Street in Houston, Texas. EFI Global, Inc. (EFI) performed this work in general accordance with Service Proposal No. 98410-20-0051 Rev.394 dated January 15, 2020, which was authorized by Mr. Gabriel Mussio, of City of Houston via issuance of Purchase Order No. PRO-4200009216. It is our understanding that potential renovations may be scheduled for the subject property.

FIELD SURVEY

Mr. Brian King [Texas Department of State Health Services (DSHS) License #60-3689], of EFI, conducted the field survey on April 14, 2020. This survey was performed in order to determine the presence of Asbestos-Containing Building Materials (ACBM) prior to commencement of renovations of the stairwell areas. The samples were generally collected in sufficient numbers to comply with U.S. Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), and DSHS protocols. These protocols require a specified number of samples be obtained, at least three (3), and analyzed based on homogeneous areas of individual building materials. A homogeneous area defined as an area of surfacing material, thermal system insulation, or miscellaneous material that is uniform in color and texture, apparently applied at similar times, and appearing identical in every other respect. The field survey included the identification and sampling of suspect ACBM, which included:

- Gypsum Wallboard and Joint Compound,
- Yellow Cove Base Mastic,
- 2'x2' Ceiling Tile (Pin Hole Pattern),
- 2'x2' Ceiling Tile (Smooth Vinyl Covering),
- 12"x12" White with Black Border Floor Tile with Yellow Mastic,
- Yellow Carpet Mastic,
- 12"x12" White Floor Tile with Yellow Mastic,
- Exterior Waterproofing @ Perimeter Wall,
- Storm Drain TSI (Mudded Joint),

- Transite Pipe Sleeve @ Generator Exhaust,
- Brown Brick Expansion Joint Caulking,
- Grey Sidewalk Expansion Joint Caulking,
- Grey Window Expansion Joint Caulking,
- Plaster Soffit, and
- Roof Cap Caulking.

Sampling: Since no "as built" drawings were available at the time of our survey to identify suspect materials, we proceeded with our observations and sample collection. The Client provided a floor plan, and the approximate location of each material sample documented on the drawing, which is included as an appendix to this report. A total of forty-nine (49) bulk samples were collected in the survey area. The samples were collected in a manner that reduces the potential for fiber release and exposure by using wet sampling methods and personal protective equipment, as necessary. Samples were deposited in secure containers for transport to our subcontract asbestos laboratory, J3 Resources, Inc. in Houston, Texas. Appropriate chain-of-custody protocols were initiated at the site for all samples.

Laboratory Analysis

The bulk samples were transported to J3 Resources' laboratory in Houston, Texas for analysis. This laboratory is a participant in the Department of Commerce, National Institute of Standards and Technology National Voluntary Laboratory Accreditation Program (NVLAP) and licensed by the DSHS (License No. 30-0273). The current Certificate of Accreditation of Asbestos Fiber Analysis for bulk samples is effective until March 31, 2020, and J3 Resources is licensed by DSHS through April 15, 2020. The material samples obtained during this survey and listed in Appendix A will be retained at the laboratory, without charge, for a period of sixty (60) days from the date of this report. Samples obtained during this survey and retained at the laboratory more than sixty (60) days will be disposed if we have not received your specific written instructions for the disposition of these samples.

Analytical Procedure. All material samples were analyzed using Polarized Light Microscopy (PLM) coupled with dispersion staining as detailed in the EPA's "Method for the Determination of Asbestos in Bulk Building Materials" (EPA/600/R-93/116). Percentages for the samples were determined by visual area estimation.

Analytical Results. The laboratory results of the sample analyses are included in Appendix A along with the Chain of Custody indicating the location of the samples collected. Based on the laboratory analyses, the following information was obtained:

- **The transite pipe sleeve collected from the emergency generator room at exterior wall was found to contain 20% Chrysotile asbestos and 2% Crocidolite asbestos (approximately 1 linear feet).**

CONCLUSIONS AND RECOMMENDATIONS

The EPA - NESHAP regulations require that all RACM be removed from a facility being demolished or renovated prior to any activity that would disturb the material. RACM is defined as (a) friable ACM, (b) Category I non-friable ACM that has become friable, (c) Category I non-friable ACM that will be or has been subject to sanding, grinding, or abating, or (d) Category II non-friable ACM that has a high probability of becoming or has become crumbled, pulverized, or

reduced to powder by the forces expected to act on the material during the course of the demolition or renovation operations.

State of Texas, the DSHS is the state's NESHAP enforcement agency for the EPA. The DSHS has also written their own regulations which mirror and at times exceed the NESHAP regulations with regard to notification requirements, definitions of RACM and categories, the need for engineering controls and wet removal techniques and the proper disposal of ACM.

The transite pipe sleeve is classified as a Category II Non-Friable ACM.

Please note that the DSHS regulations require a 10-working day notification and a Texas licensed abatement contractor to remove and dispose of asbestos-containing materials should they be impacted by proposed renovations. Based on these findings, EFI recommends that the identified asbestos-containing transite pipe sleeve be maintained under an Operations and Maintenance Program. All building staff and maintenance personnel should be notified as to the existence and locations of the ACM. This notification should inform personnel not to disturb the identified materials and include procedures to follow when this material is disturbed.

Materials Presumed To Be Asbestos-Containing. No destructive methods were utilized to locate materials in inaccessible locations (i.e. behind walls, beneath fixed objects, below grade, inside chases, etc.) or outside the immediate survey area. Consequently, any additional suspect materials, which may be uncovered by future renovation or demolition activities, and which were not sampled as a part of this asbestos survey should be considered asbestos-containing until sampling and analysis determines otherwise.

QUALIFICATIONS

This report has been prepared to assist City of Houston in determining whether or not asbestos components are present at the Hobby Airport, Fire Station No. 92 located at 7990 Paul Koonce Street in Houston, Texas. This report only describes the conditions present at the time of our survey, and the results presented here are limited, based upon the information available at the time of our survey. This report is prepared for the sole benefit of City of Houston and its affiliates and may not be relied upon by any other person or entity without the written authorization of EFI Global.

CLOSING

We appreciate the opportunity to assist you with this project. If you have any questions or require any additional information, please do not hesitate to contact us at (832) 518-5145.

Sincerely,
EFI Global, Inc.



Cuong Nguyen
Project Manager



Rick A. Anderson, P.E., CIEC.
Senior District Manager

Appendices:



Appendix A – Laboratory Report
Appendix B – Bulk Sample Location Sketch
Appendix C – Licenses and Certificates

(Projects2019\City of Houston\Hobby Fire Station No. 81\029.01934 – Fire Station No. 81 ACM svy rpt)

**APPENDIX A
LABORATORY REPORT**

J3 Resources, Inc.

6110 W. 34th Street, Houston, Texas 77092

Phone: (713) 290-0221 - Fax: (713) 290-0248

J3Resources.com



Bulk Asbestos Fiber Analysis by Polarized Light Microscopy (PLM)

Appx E Sub E 40 CFR 763 / EPA 600/R-93/116

Alex Nguyen
EFI Global, Inc.
2000 Dairy Ashford, Ste 600
Houston TX 77077

J3 Order #: JH20119009
Project #: 029.01934
Date Received: 14-Apr-2020
Date Analyzed: 16-Apr-2020
Date Reported: 17-Apr-2020

Hobby-Fire Station #81

Sample ID #	Sample Description	Asbestos Constituents	Non-Asbestos Constituents	
1-1	LAYER 1 Paint Texture, Beige, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 2 Wallboard, Brown/ White, Homogeneous	None Detected	Cellulose Fiber Fibrous Glass Non-Fibrous Material	10% <1 90%
1-2	LAYER 1 Texture, White, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 2 Wallboard, Brown/ White, Homogeneous	None Detected	Cellulose Fiber Fibrous Glass Non-Fibrous Material	10% <1 90%
1-3	LAYER 1 Texture, White, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 2 Wallboard, Brown/ White, Homogeneous	None Detected	Cellulose Fiber Fibrous Glass Non-Fibrous Material	10% <1 90%
1-4	Wallboard, Brown/ White, Homogeneous	None Detected	Cellulose Fiber Fibrous Glass Non-Fibrous Material	10% <1 90%
1-5	LAYER 1 Wall Cover, Beige, Homogeneous	None Detected	Cellulose Fiber Non-Fibrous Material	45% 55%
	LAYER 2 Joint Compound, White, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 3 Wallboard, Brown/ White, Homogeneous	None Detected	Cellulose Fiber Fibrous Glass Non-Fibrous Material	10% <1 90%

Anh Phung

Analyst


Scott Ward, Ph.D. Lab Director

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NVLAP Lab Code: 200525-0

TDSHS License: 30-0273

Page 1 of 7



Bulk Asbestos Fiber Analysis by Polarized Light Microscopy (PLM)
Appx E Sub E 40 CFR 763 / EPA 600/R-93/116


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Hobby-Fire Station #81

Sample ID #	Sample Description	Asbestos Constituents	Non-Asbestos Constituents
2-1	Cove Base Mastic, Beige, Homogeneous	None Detected	Non-Fibrous Material 100%
2-2	Cove Base Mastic, Beige, Homogeneous	None Detected	Non-Fibrous Material 100%
2-3	Cove Base Mastic, Beige, Homogeneous	None Detected	Non-Fibrous Material 100%
2-4	Cove Base Mastic, Tan, Homogeneous	None Detected	Non-Fibrous Material 100%
2-5	Cove Base Mastic, Tan, Homogeneous	None Detected	Non-Fibrous Material 100%
3-1	Ceiling Tile, White/ Beige, Homogeneous	None Detected	Cellulose Fiber 70% Mineral Wool 10% Non-Fibrous Material 20%
3-2	Ceiling Tile, White/ Beige, Homogeneous	None Detected	Cellulose Fiber 70% Mineral Wool 10% Non-Fibrous Material 20%
3-3	Ceiling Tile, White/ Beige, Homogeneous	None Detected	Cellulose Fiber 70% Mineral Wool 10% Non-Fibrous Material 20%
3-4	Ceiling Tile, White/ Beige, Homogeneous	None Detected	Cellulose Fiber 70% Mineral Wool 10% Non-Fibrous Material 20%

Anh Phung Analyst


 Scott Ward, Ph.D. Lab Director

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Bulk Asbestos Fiber Analysis by Polarized Light Microscopy (PLM)
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Sample ID #	Sample Description	Asbestos Constituents	Non-Asbestos Constituents
3-5	Ceiling Tile, White/ Beige, Homogeneous	None Detected	Cellulose Fiber 70% Mineral Wool 10% Non-Fibrous Material 20%
4-1	Ceiling Tile, White/ Beige, Homogeneous	None Detected	Cellulose Fiber 50% Mineral Wool 30% Non-Fibrous Material 20%
4-2	Ceiling Tile, White/ Beige, Homogeneous	None Detected	Cellulose Fiber 50% Mineral Wool 30% Non-Fibrous Material 20%
4-3	Ceiling Tile, White/ Beige, Homogeneous	None Detected	Cellulose Fiber 50% Mineral Wool 30% Non-Fibrous Material 20%
5-1	LAYER 1 Floor Tile, Black, Homogeneous	None Detected	Non-Fibrous Material 100%
	LAYER 2 Mastic, Yellow, Homogeneous	None Detected	Non-Fibrous Material 100%
	LAYER 3 Floor Tile, White, Homogeneous	None Detected	Non-Fibrous Material 100%
	LAYER 4 Mastic, Yellow, Homogeneous	None Detected	Non-Fibrous Material 100%
Multi-Layered Flooring			

Anh Phung Analyst


 Scott Ward, Ph.D. Lab Director

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Hobby-Fire Station #81

Sample ID #	Sample Description	Asbestos Constituents	Non-Asbestos Constituents	
5-2	LAYER 1 Floor Tile, Black, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 2 Mastic, Yellow, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 3 Floor Tile, White, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 4 Mastic, Yellow, Homogeneous	None Detected	Non-Fibrous Material	100%
Multi-Layered Flooring				
5-3	LAYER 1 Floor Tile, Black, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 2 Mastic, Yellow, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 3 Floor Tile, White, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 4 Mastic, Yellow, Homogeneous	None Detected	Non-Fibrous Material	100%
Multi-Layered Flooring				
6-1	Carpet Mastic, Yellow, Homogeneous	None Detected	Non-Fibrous Material	100%
6-2	Carpet Mastic, Yellow, Homogeneous	None Detected	Non-Fibrous Material	100%
6-3	Carpet Mastic, Yellow, Homogeneous	None Detected	Non-Fibrous Material	100%
7-1	LAYER 1 Floor Tile, Off White, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 2 Mastic, Yellow, Homogeneous	None Detected	Non-Fibrous Material	100%

Anh Phung Analyst


 Scott Ward, Ph.D. Lab Director

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Hobby-Fire Station #81

Sample ID #	Sample Description	Asbestos Constituents	Non-Asbestos Constituents	
7-2	LAYER 1 Floor Tile, Off White, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 2 Mastic, Yellow, Homogeneous	None Detected	Non-Fibrous Material	100%
7-3	LAYER 1 Floor Tile, Off White, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 2 Mastic, Yellow, Homogeneous	None Detected	Non-Fibrous Material	100%
8-1	LAYER 1 Vapor Barrier, Black, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 2 Wallboard, Brown/ Tan, Homogeneous	None Detected	Cellulose Fiber Non-Fibrous Material	10% 90%
8-2	LAYER 1 Vapor Barrier, Black, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 2 Wallboard, Brown/ Tan, Homogeneous	None Detected	Cellulose Fiber Non-Fibrous Material	10% 90%
8-3	LAYER 1 Vapor Barrier, Black, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 2 Wallboard, Brown/ Tan, Homogeneous	None Detected	Cellulose Fiber Non-Fibrous Material	10% 90%
9-1	LAYER 1 Sealant, Beige, Homogeneous	None Detected	Wollastonite Non-Fibrous Material	2% 98%
	LAYER 2 Foam Insulation, Black, Homogeneous	None Detected	Non-Fibrous Material	100%

Anh Phung

Analyst


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Hobby-Fire Station #81

Sample ID #	Sample Description	Asbestos Constituents	Non-Asbestos Constituents
9-2	LAYER 1 Sealant, Beige, Homogeneous	None Detected	Wollastonite 2% Non-Fibrous Material 98%
	LAYER 2 Foam Insulation, Black, Homogeneous	None Detected	Non-Fibrous Material 100%
9-3	LAYER 1 Sealant, Beige, Homogeneous	None Detected	Wollastonite 2% Non-Fibrous Material 98%
	LAYER 2 Foam Insulation, Black, Homogeneous	None Detected	Non-Fibrous Material 100%
10-1	Transite, Gray, Homogeneous	Chrysotile 20% Crocidolite 2%	Non-Fibrous Material 78%
11-1	Caulk, Tan, Homogeneous	None Detected	Non-Fibrous Material 100%
11-2	Caulk, Brown, Homogeneous	None Detected	Non-Fibrous Material 100%
11-3	Caulk, Tan, Homogeneous	None Detected	Non-Fibrous Material 100%
12-1	Expansion Joint Caulk, Gray, Homogeneous	None Detected	Non-Fibrous Material 100%
12-2	Expansion Joint Caulk, Gray, Homogeneous	None Detected	Non-Fibrous Material 100%
12-3	Expansion Joint Caulk, Gray, Homogeneous	None Detected	Non-Fibrous Material 100%
13-1	Door Caulk, Black, Homogeneous	None Detected	Non-Fibrous Material 100%

Anh Phung Analyst


 Scott Ward, Ph.D. Lab Director

This report relates only to the materials tested. This report is for the exclusive use of the addressed client and shall not be reproduced except in full, without written approval by J3 Resources, Inc. (J3). Samples are analyzed according to the methods listed above and are subject to the inherent limitations of PLM and interference of matrix components. Reporting limit for the above method is a function of the quantity of sample analyzed, matrix interference, sample preparation, fiber size, and distribution. Asbestos may be detected in concentrations of <1% by area if sufficient material is analyzed. J3 recommends TEM confirmation of soils, vermiculite and non-friable organically bound materials (NOB) reported as None Detected or < 1% Asbestos by PLM. All samples received in good condition unless otherwise noted. This report shall not be used to claim product approval, certification, or endorsement by NVLAP, NIST, or any agency of the federal government.



Bulk Asbestos Fiber Analysis by Polarized Light Microscopy (PLM)
Appx E Sub E 40 CFR 763 / EPA 600/R-93/116


Alex Nguyen
 EFI Global, Inc.
 2000 Dairy Ashford, Ste 600
 Houston TX 77077

J3 Order #: JH20119009
 Project #: 029.01934
 Date Received: 14-Apr-2020
 Date Analyzed: 16-Apr-2020
 Date Reported: 17-Apr-2020

Hobby-Fire Station #81

Sample ID #	Sample Description	Asbestos Constituents	Non-Asbestos Constituents	
13-2	Door Caulk, Black, Homogeneous	None Detected	Non-Fibrous Material	100%
13-3	Door Caulk, Black, Homogeneous	None Detected	Non-Fibrous Material	100%
14-1	Plaster Ceiling, White, Homogeneous	None Detected	Non-Fibrous Material	100%
14-2	LAYER 1 Plaster Ceiling, White, Homogeneous	None Detected	Non-Fibrous Material	100%
	LAYER 2 Plaster, Gray, Homogeneous	None Detected	Non-Fibrous Material	100%
14-3	Plaster Ceiling, White, Homogeneous	None Detected	Non-Fibrous Material	100%
15-1	Roof Caulk, Brown, Homogeneous	None Detected	Non-Fibrous Material	100%
15-2	Roof Caulk, Brown, Homogeneous	None Detected	Non-Fibrous Material	100%
15-3	Roof Caulk, Brown, Homogeneous	None Detected	Non-Fibrous Material	100%

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NVLAP Lab Code: 200525-0 TDSHS License: 30-0273 Page 7 of 7

IH CHAIN OF CUSTODY



J3 Resources

Open Lab Fee

J3 Order # (For use only) **119009**

Submitter Name: <u>Brian King</u>	Bill to: <u>EFI Global, Inc.</u>
Company: <u>EFI</u>	Address: <u>2000 S Dairy ASHFORD</u>
Address: _____	<u>STE. 600</u>
City/State: _____	City/State: <u>Hou. / Tx.</u> Zip: <u>77077</u>
City/State: _____ Zip: _____	PO #: <u>029.01934</u>

Project Information

Project Name: <u>HOBBY - FIRE STATION # 81</u>	Project Manager: <u>CN</u>
Project #: <u>029.01934</u>	Telephone - Office/Cell
Reports - Email Address: <u>CN/RAA/</u>	
Invoice - Email Address: <u>CN/RAA/GD</u>	Notification By: Email: <input type="checkbox"/> Verbal: <input type="checkbox"/>
Special Instructions:	

Turnaround Times - Please Select One

Emergency* <input type="checkbox"/>	1 Day <input type="checkbox"/>	2 Day <input type="checkbox"/>	3 Day <input checked="" type="checkbox"/>	5 Day <input type="checkbox"/>
-------------------------------------	--------------------------------	--------------------------------	---	--------------------------------

ASBESTOS

PLM - Bulk	PCM - Air	TEM - Air	TEM - Bulk	TEM - Water	TEM - Dust	TEM/PLM Soil/Vermiculite/Ore
EPA 600/R-93/116 <input checked="" type="checkbox"/> Visual Estimation (<1%) <input type="checkbox"/> 400 Point Count 0.25% <input type="checkbox"/> 1,000 Point Count 0.1% <input type="checkbox"/> Gravimetric Reduction <input type="checkbox"/> Matrix Reduction (+/-) <input type="checkbox"/> NIOSH 9002 <input type="checkbox"/> OSHA ID-191	<input type="checkbox"/> NIOSH 7400 <input type="checkbox"/> ASTM D7201 <input type="checkbox"/> ISO 8672 <input type="checkbox"/> OSHA ID-160	<input type="checkbox"/> AHERA <input type="checkbox"/> NIOSH 7402 <input type="checkbox"/> ASTM D6281 <input type="checkbox"/> ISO 10312 <input type="checkbox"/> ISO 13794	<input type="checkbox"/> Gravimetric Reduction (<1%) <input type="checkbox"/> Matrix Reduction (+/-) <input type="checkbox"/> Qualitative (+/-) <input type="checkbox"/> Drop Mount <input type="checkbox"/> Filtration	<input type="checkbox"/> EPA 100.2 Drinking Water <input type="checkbox"/> >10 µm fibers <input type="checkbox"/> ≥0.5 µm fibers <input type="checkbox"/> EPA 100.2 Effluent / WW Received on Ice: <input type="checkbox"/> Yes <input type="checkbox"/> No Temp: _____	<input type="checkbox"/> ASTM D5755 Microvac <input type="checkbox"/> ASTM D6480 Wipe <input type="checkbox"/> 600/J-93/167 Carpet - EPA <input type="checkbox"/> Bulk Dust Qualitative	<input type="checkbox"/> ASTM 7521-TEM (+/-) <input type="checkbox"/> ASTM 7521-TEM (<1%) <input type="checkbox"/> CARB 435-Modified <input type="checkbox"/> Soil - PLM Only (+/-) <input type="checkbox"/> Vermiculite - TEM (+/-) <input type="checkbox"/> Vermiculite-Cincinnati <input type="checkbox"/> Erionite ID

METALS

Flame AA	Graphite Furnace AA - LEAD	ICP	SILICA/PARTICULATES
<input type="checkbox"/> Lead in Paint - SW846 7420/3050B <input type="checkbox"/> Lead in Air - NIOSH 7082 <input type="checkbox"/> Lead in Wipes - SW846 7420/3050B <input type="checkbox"/> Lead in Soil - SW846 7420/3050B <input type="checkbox"/> TCLP - SW846-1311/6010B	<input type="checkbox"/> Drinking Water - EPA 200.9 <input type="checkbox"/> Wastewater - SW846-7421 <input type="checkbox"/> Soil/Sludge - SW846-7421 <input type="checkbox"/> Air - NIOSH 7105	<input type="checkbox"/> Elements in Air - NIOSH 7300 <input type="checkbox"/> Wipe/Soil - SW846-6010B <input type="checkbox"/> Effluent - SW846-6010B <input type="checkbox"/> Welding Fume - NIOSH 7300M	<input type="checkbox"/> Respirable Crystalline Silica NIOSH 7500 / OSHA 142 <input type="checkbox"/> NIOSH 0500 - Total Particulates <input type="checkbox"/> NIOSH 0600 - Respirable Particulates

Total Number of Samples Submitted: 49 Positive Stop: YES NO

Signatures

Relinquished By: <u>[Signature]</u>	Date: <u>4-14-20</u> Time: _____
Received By: <u>[Signature]</u>	Date: <u>4/14/20</u> Time: <u>10:14</u>
Relinquished By: _____	Date: _____ Time: _____
Received By: _____	Date: _____ Time: _____

*Emergency TAT requires prior lab notification. All samples analyzed outside normal business hours are charged at Emergency rate.
 **TAT's are in Business Days rather than Hours (i.e. 1 Day TAT = End of Next Business Day)

IH CHAIN OF CUSTODY



Project Name _____
Project Number _____

Page ____ of ____

SAMPLE IDENTIFICATION

SAMPLE NUMBER	SAMPLE LOCATION / MATERIAL	VOLUME/CONDITION
✓ 1-1	GWB w/ PAINT / TEST	
✓ -2	↓	
✓ -3		
✓ -4		
✓ -5		
✓ 2-1	CONCRETE MASTIC	
✓ -2	↓	
✓ -3		
✓ -4		
✓ -5		
✓ 3-1	2'x2' CCL PINKISH	
✓ -2	↓	
✓ -3		
✓ -4		
✓ -5		
✓ 4-1	2'x2' CCL Smooth Vinyl / GREENISH	
✓ -2	↓	
✓ -3		
✓ 5-1	12"x12" WH. & BLC BOARD FFL w/ yellow mastic	
✓ -2	↓	
✓ -3		
✓ 6-1	yellow Carpet mastic	
✓ -2	↓	
✓ -3		
✓ 7-1	12"x12" wh. FFL w/ yell mastic	
✓ -2	↓	
✓ -3		
✓ 8-1	EXTERIOR WATER PROOFING & FLOORING	
✓ -2	↓	
✓ -3		
✓ 9-1	STORM DRAIN (JOINT MOUNTED) TSI	
✓ -2	↓	
✓ -3		
Comments/Special Instructions:		
✓ 10-1	TRANSIT SIGN @ GENERATOR EXHAUST	

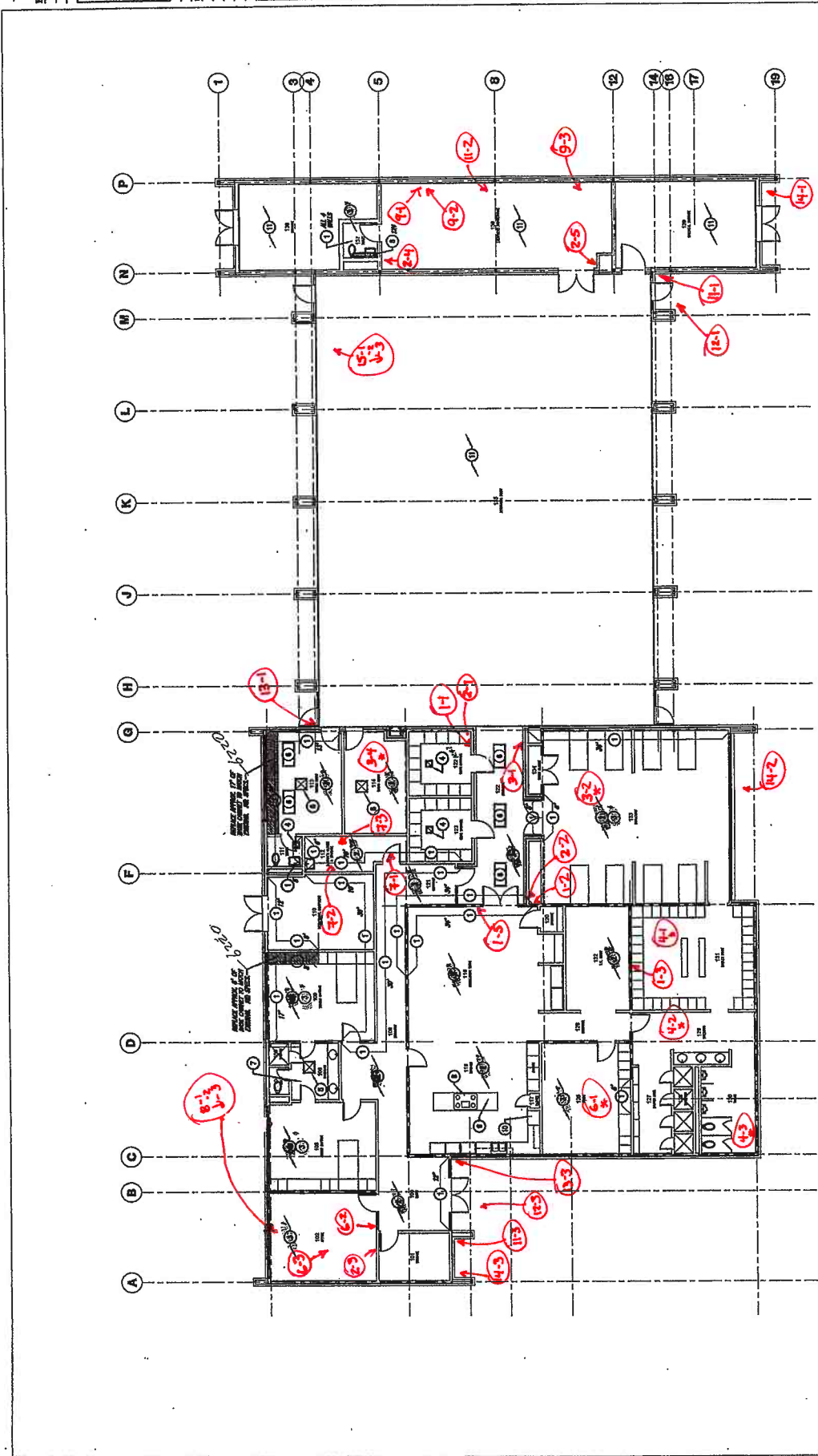
IH CHAIN OF CUSTODY

Project Name/Number _____

SAMPLE IDENTIFICATION

SAMPLE NUMBER	SAMPLE LOCATION / MATERIAL	VOLUME / CONDITION
✓ 11-1	Brick Joint Caulking (BEN)	
✓ 1-2	↓	
✓ 1-3	↓	
✓ 12-1	Side Wall Expansion Jnt Caulking (GRY)	
✓ 1-2	↓	
✓ 1-3	↓	
✓ 13-1	Door Frame Caulking (GRY)	
✓ 1-2	↓	
✓ 1-3	↓	
✓ 14-1	Plastic Ceiling (Suffit)	
✓ 1-2	↓	
✓ 1-3	↓	
15-1	Roof cap caulk	
-2	↓	
-3	↓	
Comments/Special Instructions:		

APPENDIX B
BULK SAMPLE LOCATION SKETCH



- GENERAL NOTES**
1. REPLACE ALL EXISTING CEILING, WALL, AND FLOOR FINISHES WITH THE FOLLOWING:
 - a. CEILING: 2" x 4" LUMBER FRAME TO MATCH EXISTING.
 - b. WALL: 1/2" GYPSUM BOARD TO MATCH EXISTING.
 - c. FLOOR: 4" CONCRETE SLAB TO MATCH EXISTING.
 2. KEYED NOTE NO. 1 AND THE EXISTING MATERIAL, REMOVE, REPAIR, OR REPLACE AS NECESSARY FOR MAINTENANCE AND ASSOCIATED REPAIRS.
 3. KEYED NOTE NO. 2 THROUGH 7 INDICATE REPAIRS TO BE MADE TO THE EXISTING STRUCTURE. ALL REPAIRS SHALL BE DONE ON A NEW FRAME BASIS AND INCLUDED IN THE TOTAL BID PRICE.
 4. KEYED NOTE NO. 8 THROUGH 11 AND ALL WORKING NOTES REFER TO BE COMPLETED IN THE WORK AREA.
 5. CAREFULLY REMOVE AND REPLACE ALL WORKING MATERIALS TO ACCOMPLISH REPAIRS AND MAINTENANCE. REPAIR AND MAINTENANCE SHALL BE DONE IN ACCORDANCE WITH THE CONTRACT AND ALL APPLICABLE CODES.
 6. ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CONTRACT AND ALL APPLICABLE CODES.
- KEYED NOTES**
1. REPLACE ALL EXISTING CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 2. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 3. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 4. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 5. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 6. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 7. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 8. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 9. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 10. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 11. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 12. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 13. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 14. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 15. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 16. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 17. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 18. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.
 19. REPLACE CEILING GIRDERS AND BRACES IN DESIGNATED ROOM.

1. Floor Plan
SCALE: 1/8" = 1'-0"



REVISIONS

NO.	DESCRIPTION	DATE	BY

PROJECT NAME
Reroof ARFF Station 81
Hobby Airport

ARCHITECT
Anderson, McManis and
Hess, Architects
1000 North Main Street
Suite 100
Portland, OR 97227
Tel: 503.228.1111
Fax: 503.228.1112

PROJ. NO. 02-001
DATE 01/20/02
SCALE 1/8" = 1'-0"

PROJECT NO. 02-001
DATE 01/20/02
SCALE 1/8" = 1'-0"

PROJECT NO. 02-001
DATE 01/20/02
SCALE 1/8" = 1'-0"

PROJECT NO. 02-001
DATE 01/20/02
SCALE 1/8" = 1'-0"



A2.001

**APPENDIX C
LICENSES AND CERTIFICATES**



Texas Department of State Health Services

EFI GLOBAL INC

is certified to perform as an

Asbestos Consultant Agency

in the State of Texas and is hereby governed by the rights, privileges and responsibilities set forth in Texas Occupations Code, Chapter 1954 and Title 12, Texas Administrative Code, Chapter 295 relating to Texas Asbestos Health Protection, as long as this license is not suspended or revoked.



License Number: 100409

Expiration Date: 04/26/2022

Control Number: 97284

*John Hellerstedt, M.D.,
Commissioner of Health*

(Void After Expiration Date)

VOID IF ALTERED NON-TRANSFERABLE

SEE BACK



**Texas Department of
State Health Services**

Asbestos Individual Consultant

RICK ALLEN ANDERSON

License No. 105042

Control No. 97636

Expiration Date: 28-Dec-2021



**Texas Department of
State Health Services**

Asbestos Inspector

BRIAN A KING

License No. 603689

Control No. 98981

Expiration Date: 6/14/2020



Quick Start Menu

To start choose an option and you will return to this Quick Start menu after you have finished. If no licenses display under the options, and you are licensed, select 'Add Licenses to Registration' to add your license(s) to your registration. Go to Asbestos/Demo Notification menu below to submit, search or pay for a Notification invoice.

Manage your license information

- Asbestos Laboratory #300273 **Address Change** **Select**
- Asbestos Laboratory #300457 **Address Change** **Select**

Start a New Application or Take An Exam

What are you applying for?

Select

License Information		Hide Details
License Number:	#300273	
License Type	Asbestos Laboratory	
License Status:	Current	
License Expiry:	04/15/2022	
License Information		Hide Details
License Number:	#300457	
License Type	Asbestos Laboratory	
License Status:	Current	
License Expiry:	04/17/2022	



TEXAS DEPARTMENT OF STATE HEALTH SERVICES

J3 RESOURCES INC

is certified to perform as a

**Asbestos Laboratory
PCM, PLM, TEM**

*in the State of Texas within the purview of Texas Occupations Code, chapter 1954, so long as this license is not suspended or
revoked and is renewed according to the rules adopted by the Texas Board of Health.*

A handwritten signature in cursive script, appearing to read "John Hellerstedt".

*John Hellerstedt, M.D.
Commissioner of Health*

License Number: 300273

Control Number: 96276

Expiration Date: 4/15/2020

(Void After Expiration Date)

VOID IF ALTERED NON-TRANSFERABLE



TEXAS DEPARTMENT OF STATE HEALTH SERVICES

J3 RESOURCES INC
J3 RESOURCES, INC.

is certified to perform as a

Asbestos Laboratory
PLM

in the State of Texas within the purview of Texas Occupations Code, chapter 1954, so long as this license is not suspended or revoked and is renewed according to the rules adopted by the Texas Board of Health.

A handwritten signature in black ink, appearing to read "John Hesterstedt".

John Hesterstedt, M.D.
Commissioner of Health

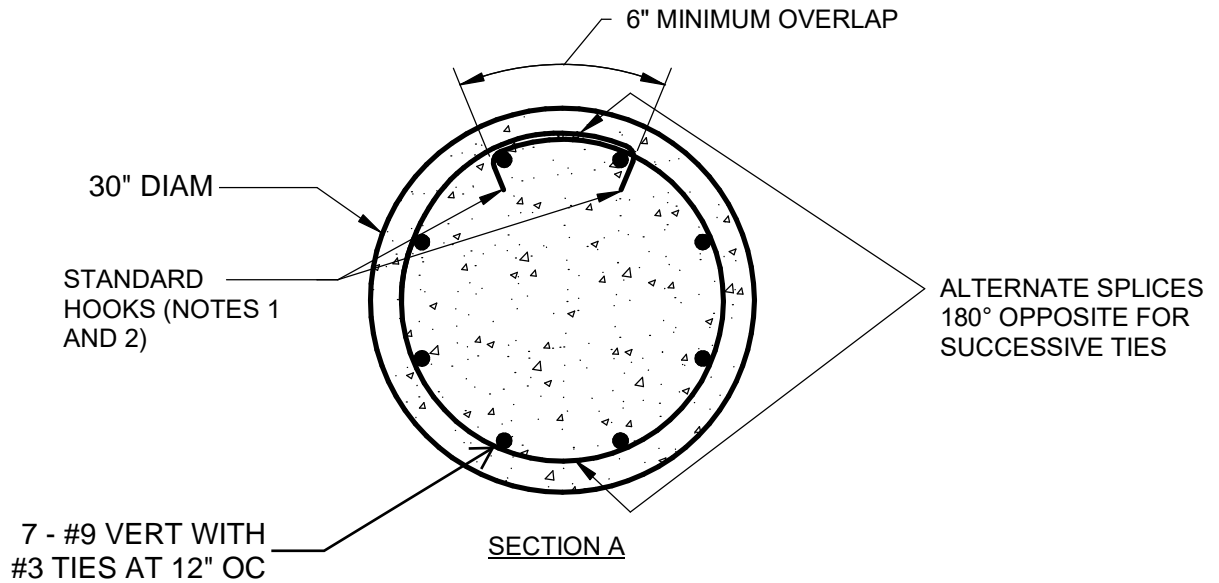
License Number: 300457

Control Number: 96275

Expiration Date: 4/17/2020

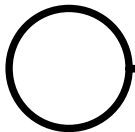
(Void After Expiration Date)

VOID IF ALTERED NON-TRANSFERABLE



NOTES:

1. ENDS OF CIRCULAR TIES SHALL TERMINATE WITH STANDARD HOOKS THAT ENGAGE A LONGITUDINAL COLUMN BAR. AT CONTRACTOR'S OPTION, ONE ADDITIONAL #4 LONGITUDINAL BAR MAY BE ADDED AT EACH SPLICE LOCATION TO ANCHOR ONE OF THE HOOKS. THIS IS TO SIMPLIFY TIE FABRICATION WHEN THE NUMBER AND SPACING OF LONGITUDINAL COLUMN BARS VARIES THROUGHOUT THE PROJECT.
2. REFER TO TYPICAL DETAIL FOR TIE HOOK DIMENSIONS.



DRILLED PIER REINFORCEMENT

NO SCALE

HOU ARFF 81

HOOD INFORMATION - Job#4420331

HOOD NO	TAG	MODEL	LENGTH	MAX COOKING TEMP	TYPE	APPLIANCE DUTY	DESIGN CFM/Ft	TOTAL EXH CFM	EXHAUST PLENUM RISER(S)				TOTAL SUPPLY CFM	HOOD CONSTRUCTION	HOOD CONFIG				
									WIDTH	LENG	HEIGHT	DIA			CFM	VEL	SP	END TO END	ROW
1		6024 ND-2-PSP-FB	8' 0"	600 Deg	1	Heavy	350	2800		4'	18"	2800	1584	-1.038"	2240	430 SS	Where Exposed	ALONE	ALONE

HOOD INFORMATION

HOOD NO	TAG	FILTER(S)				LIGHT(S)				UTILITY CABINET(S)				FIRE SYSTEM PIPING	HOOD HANGING WEIGHT		
		TYPE	QTY	HEIGHT	LENGTH	EFFICIENCY @ 7 MICRONS	QTY	TYPE	WIRE GUARD	LOCATION	SIZE	TYPE	SIZE			ELECTRICAL MODEL #	SWITCHES QUANTITY
1		Captrate Solo Filter	5	20"	16"	95% See Filter Spec	3	L55 Series E26	ND	Right	12"x60"x24"	Ansul R102	3.0	DCV-1111	1 Light 1 Fan	YES	728 LBS

HOOD OPTIONS

HOOD NO	TAG	OPTION
1		FIELD WRAPPER 18.00' High Front, Left, Right, Back FINISHED BACK - GROUND/POLISH 96.00' Long RISER SENSOR INSTALL 3IN DBL

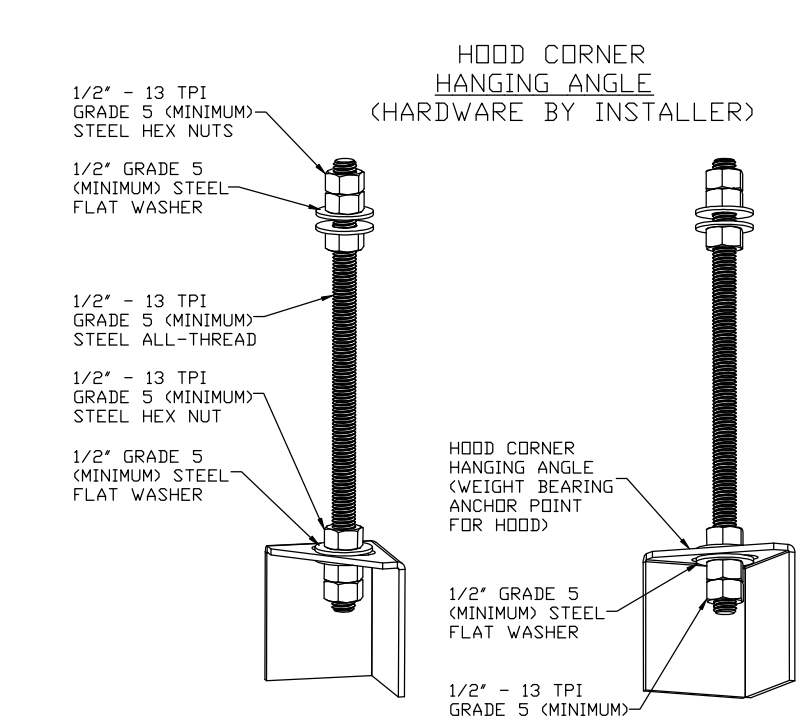
PERFORATED SUPPLY PLENUM(S)

HOOD NO	TAG	POS	LENGTH	WIDTH	HEIGHT	TYPE	RISER(S)			
							WIDTH	LENG	DIA	CFM
1		Back	108'	12'	6'	MJA	10"	28"	560	0.125"
							10"	28"	560	0.125"
							10"	28"	560	0.125"
1		Front	108'	12'	6'	MJA	10"	28"	560	0.125"
							10"	28"	560	0.125"
							10"	28"	560	0.125"

Fire System Information - Job#4420331

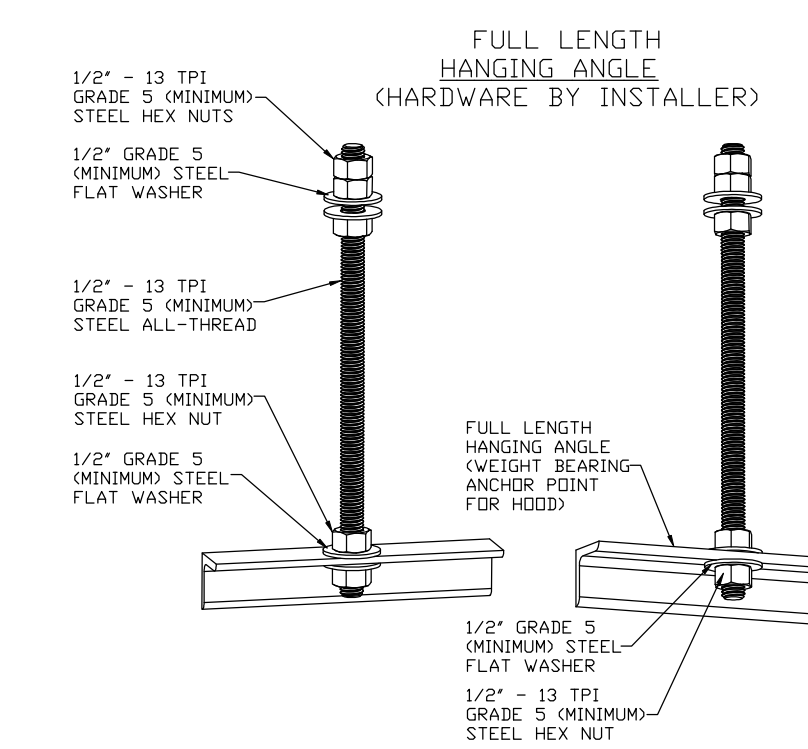
FIRE SYSTEM NO	Tag	TYPE	SIZE	FLOW POINTS	INSTALLATION	
					SYSTEM	LOCATION ON HOOD
1		Ansul R102	3.0	3	Fire Cabinet Right	Right, Hood 1

ETL LISTING DESCRIPTION BLOCK
 THE CAPTIVE AIRE MODEL ND HAS BEEN E.T.L. TESTED, LISTED, AND APPROVED TO EXHAUST A MINIMUM OF 150/200/250 CFM PER LINEAR FOOT OVER 450/600/700 DEGREE COOKING EQUIPMENT



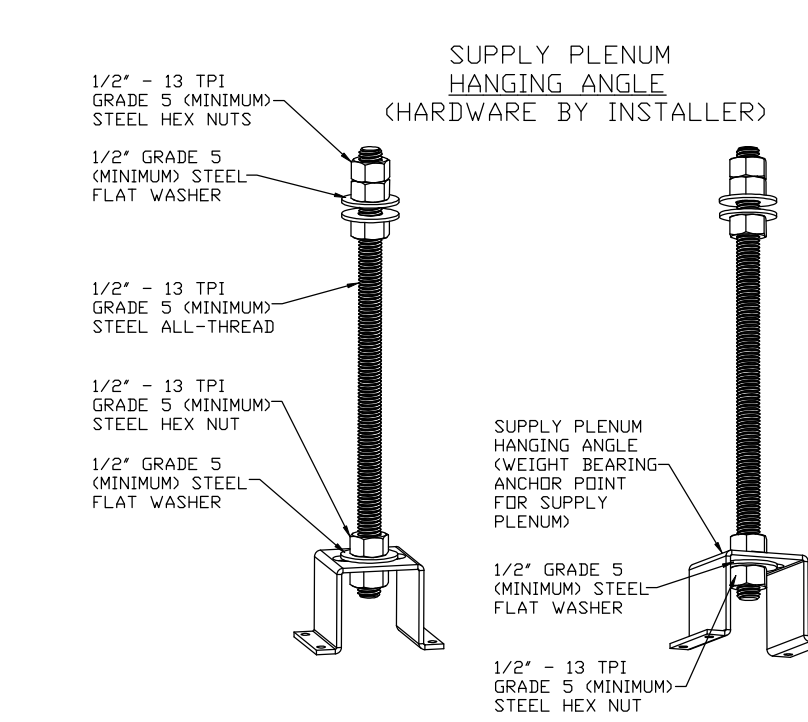
ASSEMBLY INSTRUCTIONS

HANGING ANGLE MUST BE SUPPORTED WITH 1/2" - 13 TPI GRADE 5 (MINIMUM) ALL-THREAD SANDWICH HANGING ANGLES AND CEILING ANCHOR POINTS WITH 1/2" GRADE 5 (MINIMUM) STEEL FLAT WASHERS AND 1/2" - 13 TPI GRADE 5 (MINIMUM) HEX NUTS AS SHOWN. MUST USE DOUBLED HEX NUT CONFIGURATION BENEATH HOOD HANGING ANGLES AND ABOVE CEILING ANCHORS. MAINTAIN 1/4" OF EXPOSED THREADS BENEATH BOTTOM HEX NUT. TORQUE ALL HEX NUTS TO 57 FT-LBS.



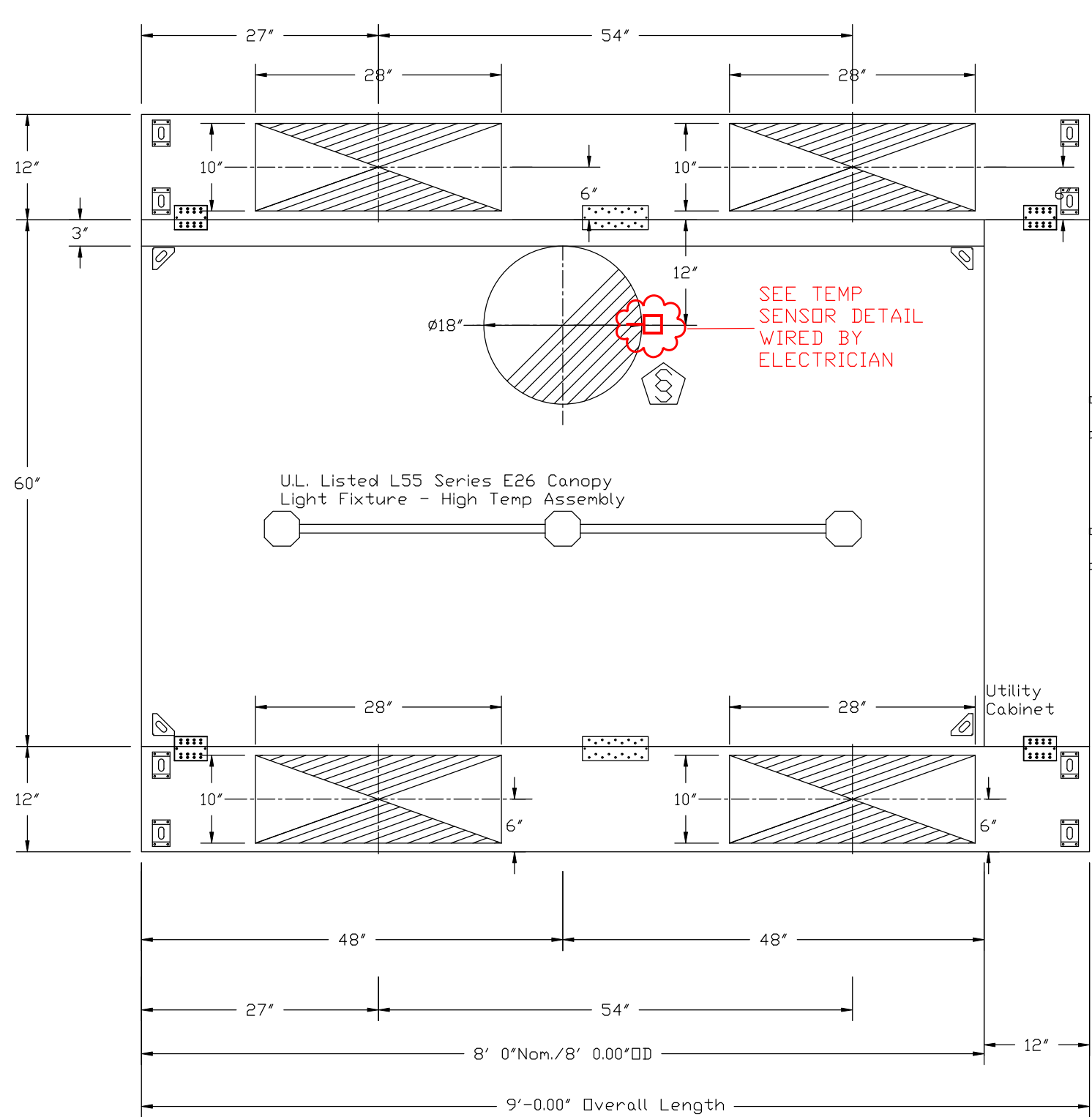
ASSEMBLY INSTRUCTIONS

HANGING ANGLE MUST BE SUPPORTED WITH 1/2" - 13 TPI GRADE 5 (MINIMUM) ALL-THREAD SANDWICH HANGING ANGLES AND CEILING ANCHOR POINTS WITH 1/2" GRADE 5 (MINIMUM) STEEL FLAT WASHERS AND 1/2" - 13 TPI GRADE 5 (MINIMUM) HEX NUTS AS SHOWN. MUST USE DOUBLED HEX NUT CONFIGURATION ABOVE CEILING ANCHORS. SINGLE HEX NUT BENEATH HANGING ANGLE IS ACCEPTABLE FOR FULL LENGTH HANGING ANGLES. MAINTAIN 1/4" OF EXPOSED THREADS BENEATH BOTTOM HEX NUT. TORQUE ALL HEX NUTS TO 57 FT-LBS.



ASSEMBLY INSTRUCTIONS

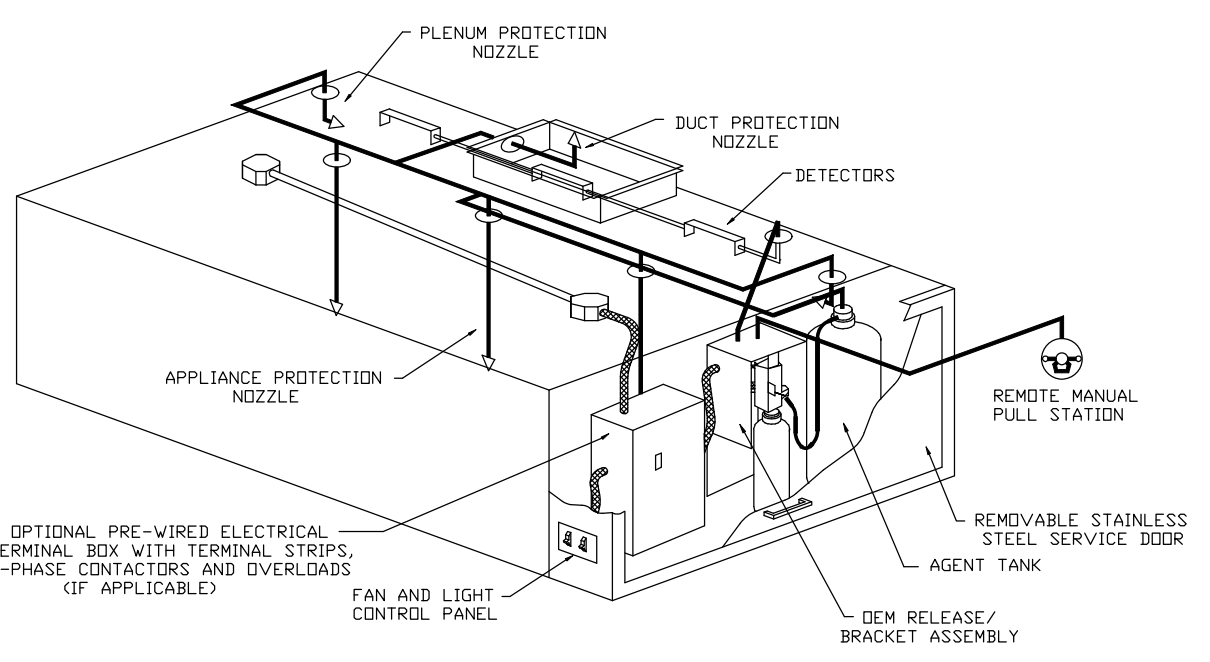
HANGING ANGLE MUST BE SUPPORTED WITH 1/2" - 13 TPI GRADE 5 (MINIMUM) ALL-THREAD SANDWICH HANGING ANGLES AND CEILING ANCHOR POINTS WITH 1/2" GRADE 5 (MINIMUM) STEEL FLAT WASHERS AND 1/2" - 13 TPI GRADE 5 (MINIMUM) HEX NUTS AS SHOWN. MUST USE DOUBLED HEX NUT CONFIGURATION ABOVE CEILING ANCHORS. SINGLE HEX NUT BENEATH HANGING ANGLE IS ACCEPTABLE FOR PSP HANGING ANGLES. MAINTAIN 1/4" OF EXPOSED THREADS BENEATH BOTTOM HEX NUT. TORQUE ALL HEX NUTS TO 57 FT-LBS.



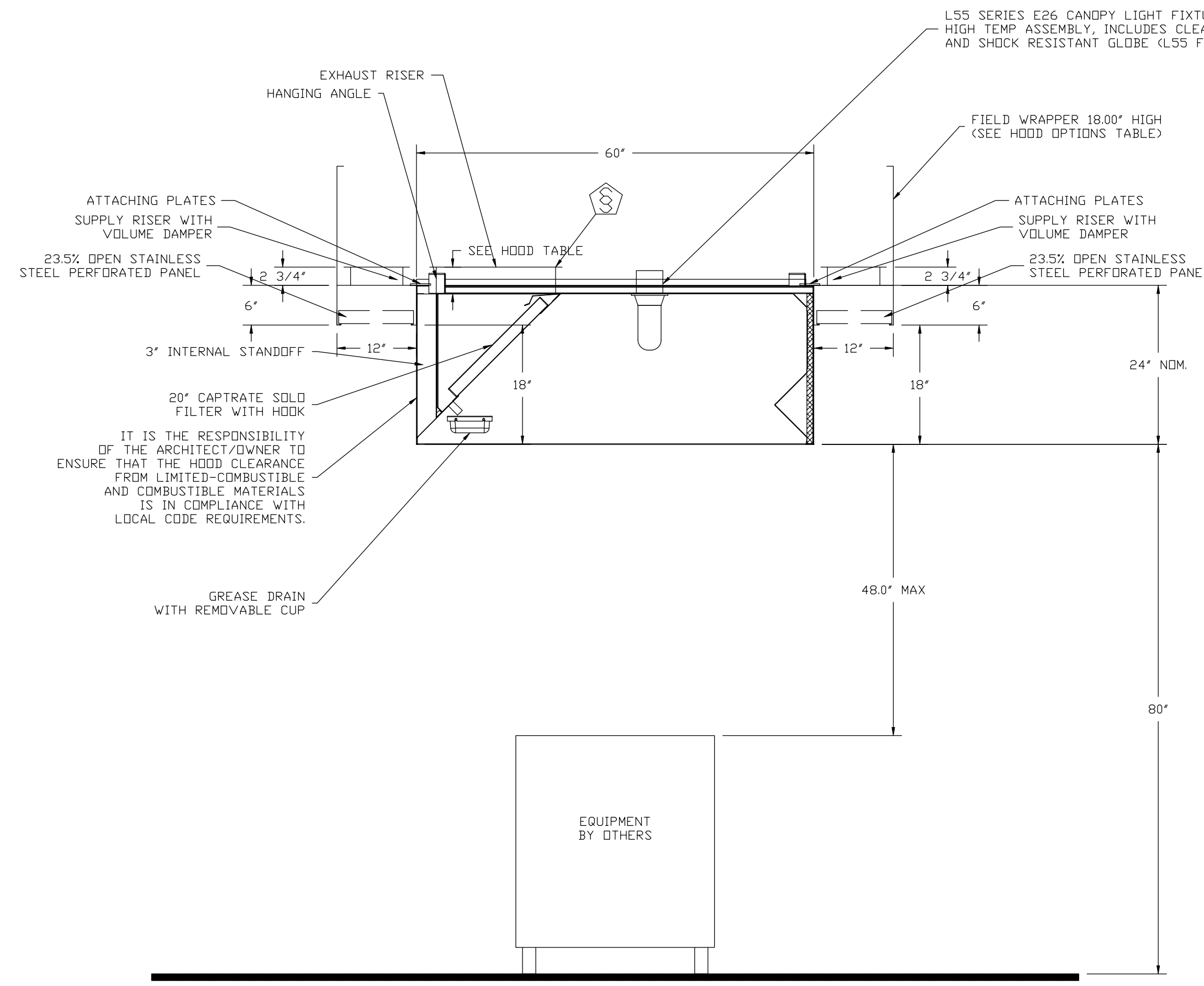
PLAN VIEW - Hood #1
 8' 0" LONG 6024ND-2-PSP-FB

SPECIFICATIONS

THE RESTAURANT FIRE SUPPRESSION SYSTEM SHALL BE THE PRE-ENGINEERED TYPE WITH A FIXED NOZZLE AGENT DISTRIBUTION NETWORK. IT SHALL BE LISTED WITH UNDERWRITERS LABORATORIES, INC. (UL).
 THE SYSTEM SHALL BE CAPABLE OF AUTOMATIC DETECTION AND ACTUATION WITH LOCAL OR REMOTE MANUAL ACTUATION. ACCESSORIES SHALL BE AVAILABLE FOR MECHANICAL OR ELECTRICAL GAS LINE SHUT-OFF APPLICATIONS.
 THE EXTINGUISHING AGENT SHALL BE A POTASSIUM CARBONATE, POTASSIUM ACETATE-BASED FORMULATION DESIGNED FOR FLAME KNOCKDOWN AND SECUREMENT OF GREASE RELATED FIRES. IT SHALL BE AVAILABLE IN PLASTIC CONTAINERS WITH INSTRUCTIONS FOR LIQUID AGENT HANDLING AND USAGE.
 THE REGULATED RELEASE MECHANISM SHALL BE COMPATIBLE WITH A FUSIBLE LINK DETECTION SYSTEM. THE FUSIBLE LINK SHALL BE SELECTED AND INSTALLED ACCORDING TO THE OPERATING TEMPERATURE IN THE VENTILATING SYSTEM. THE FUSIBLE LINK SHALL BE SUPPORTED BY A DETECTOR BRACKET/LINKAGE ASSEMBLY.



TYPICAL ANSUL R-102 SYSTEM LAYOUT



SECTION VIEW - MODEL 6024ND-2-PSP-FB HOOD - #1

System Design Verification (SDV)

If ordered, CAS Service will perform a System Design Verification (SDV) once all equipment has had a complete start up per the Operation and Installation Manual. Typically, the SDV will be performed after all inspections are complete.

Any field related discrepancies that are discovered during the SDV will be brought to the attention of the general contractor and corresponding trades on site. These issues will be documented and forwarded to the appropriate sales office. If CAS Service has to resolve a discrepancy that is a field issue, the general contractor will be notified and billed for the work. Should a return trip be required due to any field related discrepancy that cannot be resolved during the SDV, there will be additional trip charges.

During the SDV, CAS Service will address any discrepancy that is the fault of the manufacturer. Should a return trip be required, the general contractor and appropriate sales office will be notified. There will be no additional charges for manufacturer discrepancies.

***** NOTE *****
 ALL WALLS AND STRUCTURES THAT COME WITHIN 18" OF HOOD MUST BE METAL STUDS AND SHEETROCK. WOOD STUDS OR ANY OTHER COMBUSTIBLE MATERIAL WITHIN 18" OF HOOD NOT ALLOWED

***** NOTE *****
 HOOD MANUFACTURER RECOMMENDS NO RETURNS OR 4-WAY DIFFUSERS WITHIN 10 FEET OF HOOD IN ALL DIRECTIONS.

***** NOTE *****
 MAKE-UP AIR SHALL BE DELIVERED INTO SPACE IN MANNER THAT WILL NOT DISRUPT HOODS ABILITY TO CAPTURE AND CONTAIN.

REVISIONS

NO.	DESCRIPTION	DATE

HANGING ANGLE DETAILS

HOOD STYLE / MODEL	450 DEGREES cfm/ft.	600 DEGREES cfm/ft.	700 DEGREES cfm/ft.
CANOPY ND2	150	200	250
WITH END PANELS (15% reduction)			
SLOPED SMD-2	228	294	-
ISLAND ND-2W1	289	300	350
ND1	346	422	475

ETL HOOD LISTING DETAIL

*HOOD AND NUTS TO BE SUPPLIED BY INSTALLING CONTRACTOR. HANGING ANGLE IS PRE-PACKED AT FACTORY.

HOOD LENGTH	DUCT AREA	DUCT DEPTH
450	144	14
600	225	14
700	245	14

CALCULATIONS UTILIZED

CAPTIVE-AIRE HOODS ARE BUILT IN COMPLIANCE WITH:

UL LISTED	UL LISTED	UL LISTED	UL LISTED
ETL LISTED	ETL LISTED	ETL LISTED	ETL LISTED

BUILDING CODES

MATERIAL	CLEARANCE	REDUCTION SYSTEM
NON-COMBUSTIBLE	NONE REQUIRED	
LIMITED-COMBUSTIBLE	3" UNINSULATED STANDOFF	
COMBUSTIBLE	1" INSULATED STANDOFF	

CLEARANCE TO COMBUSTIBLES

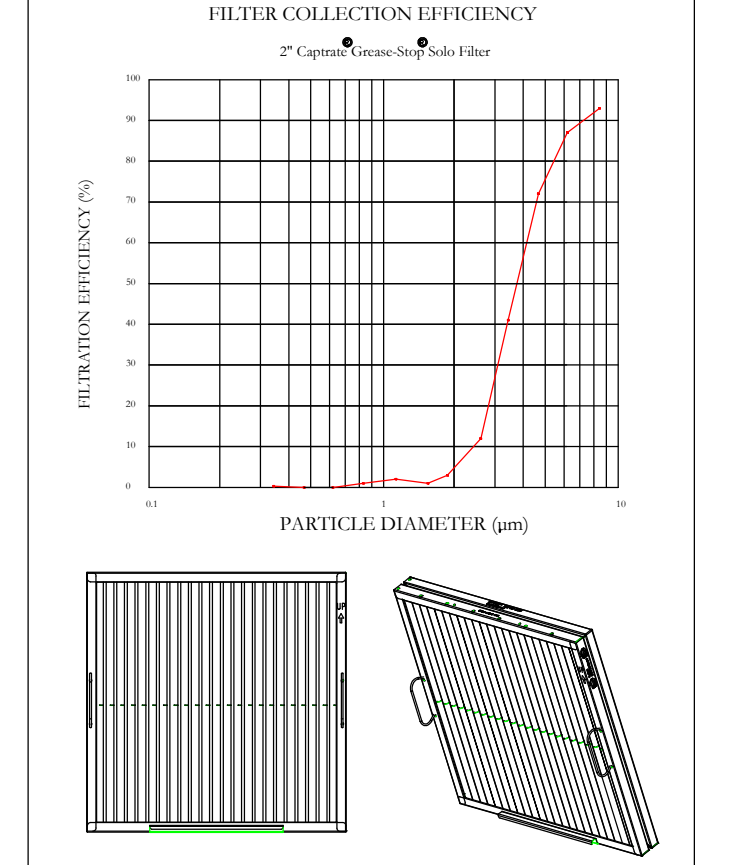
INSTALLATION

- ALL ELECTRICAL "FIELD" CONNECTIONS AND RELATED INTERCONNECTING BY ELECTRICAL CONTRACTORS.
- ALL PLUMBING "FIELD" CONNECTIONS AND RELATED INTERCONNECTING BY PLUMBING CONTRACTORS.
- HANGING BRACKETS LOCATED AND WELDED AS SHOWN ON PLANS. ALL OTHER HANGER MATERIALS PROVIDED BY INSTALLING CONTRACTORS.
- ALL CONDITIONS FROM CAPTIVE-AIRE HOODS PER MECHANICAL CONTRACTORS' PLANS.
- COOKING EQUIPMENT TO SHUTOFF IN EVENT OF FIRE.
- SHUTOFF PANS TO TURN ON IN EVENT OF FIRE.
- ALL LIGHTS, FIXTURES SHOWN INSTALLED BY CAPTIVE-AIRE ARE FACTORY PROVIDED. INTERCONNECTING BETWEEN HOODS AND TO SWITCHES BY ELECTRICAL CONTRACTORS.
- LAMPS FOR LIGHT FIXTURES BY INSTALLING CONTRACTORS.
- SEISMIC RESTRAINTS ARE RESPONSIBILITY OF INSTALLING CONTRACTOR.
- INSTALLING CONTRACTORS ASSUME ALL RELATED RESPONSIBILITY FOR VERIFICATION OF DIMENSIONAL DATA CONTAINED ON THESE DOCUMENTS FOR ACCURACY, INTEGRATION, AND ADMINISTRATION OF CODE REQUIREMENTS IN EFFECT PRIOR TO ANY RELEASE FOR PRODUCTION OF EQUIPMENT SHOWN.

ADDITIONAL

- WRITTEN HOOD DIMENSIONS HAVE PRECEDENCE OVER SCALE.
- SHOWN AND "TYPED" COPIES OF THIS DOCUMENT MUST BE RECEIVED BY THE FACTORY PRIOR TO ANY RELEASE FOR PRODUCTION OF EQUIPMENT SHOWN.

GENERAL NOTES



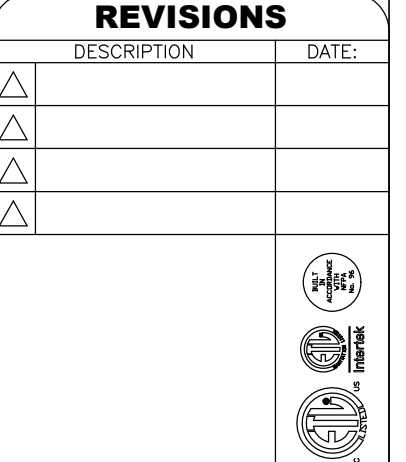
CaptiveAir Captrate Solo Filter
 ETL-Listed Grease Extracting Filters
 Made From 430 Stainless Steel

FILTER DETAIL

FOR QUESTIONS, CALL
 FERNANDO JIMENEZ - MARIO NUNEZ - CESAR GARCIA
 EMAIL - meg26@captiveaire.com
 12 Greenway Plaza #1651
 HOUSTON, TX 77046
 PHONE: (346) 330-2007 FAX: 919-516-8746

CUSTOMER APPROVAL TO MANUFACTURE

Approved as Noted
 Approved with ND Exception Taken
 Revised and Resubmit
 SIGNATURE _____
 Your Title _____ Date _____



Houston Airport System
 HOUSTON, TX, 77061

DATE: 7/1/2020
DWG.#: 4420331
DRAWN BY:
SCALE: 3/4" = 1'-0"
MASTER DRAWING
SHEET NO. 1

EXHAUST FAN INFORMATION - Job#4420331

FAN UNIT NO	TAG	FAN UNIT MODEL #	CFM	ESP	RPM	MOTOR ENCL	HP	BHP	Ø	VOLT	FLA	DISCHARGE VELOCITY	WEIGHT (LBS)	SDNES
1		DUI80HFA	2800	1.450	1297	DDP,PREMIUM	1.500	1.0610	3	208	6.6	647 FPM	174	18.9

MUA FAN INFORMATION - Job#4420331

FAN UNIT NO	TAG	FAN UNIT MODEL #	BLDWER	HOUSING	MIN CFM	DESIGN CFM	ESP	RPM	MOTOR ENCL	HP	BHP	Ø	VOLT	FLA	MCA	MDCP	WEIGHT (LBS)	SDNES
2		A1-15D	15MF-1-MDD	A1	-	2240	0.500	2059	DDP,PREMIUM	2.000	1.4040	3	208	6.1	7.7A	15A	259	29

FAN OPTIONS

FAN UNIT NO	TAG	OPTION (Qty - Descr)
1		1 - Grease Box
2		1 - Gravity Backdraft Damper for Size 1 Housing
		1 - Separate 120V Wiring Package (Required and used only for DCV or Prewire with VFD) - Three Phase Only

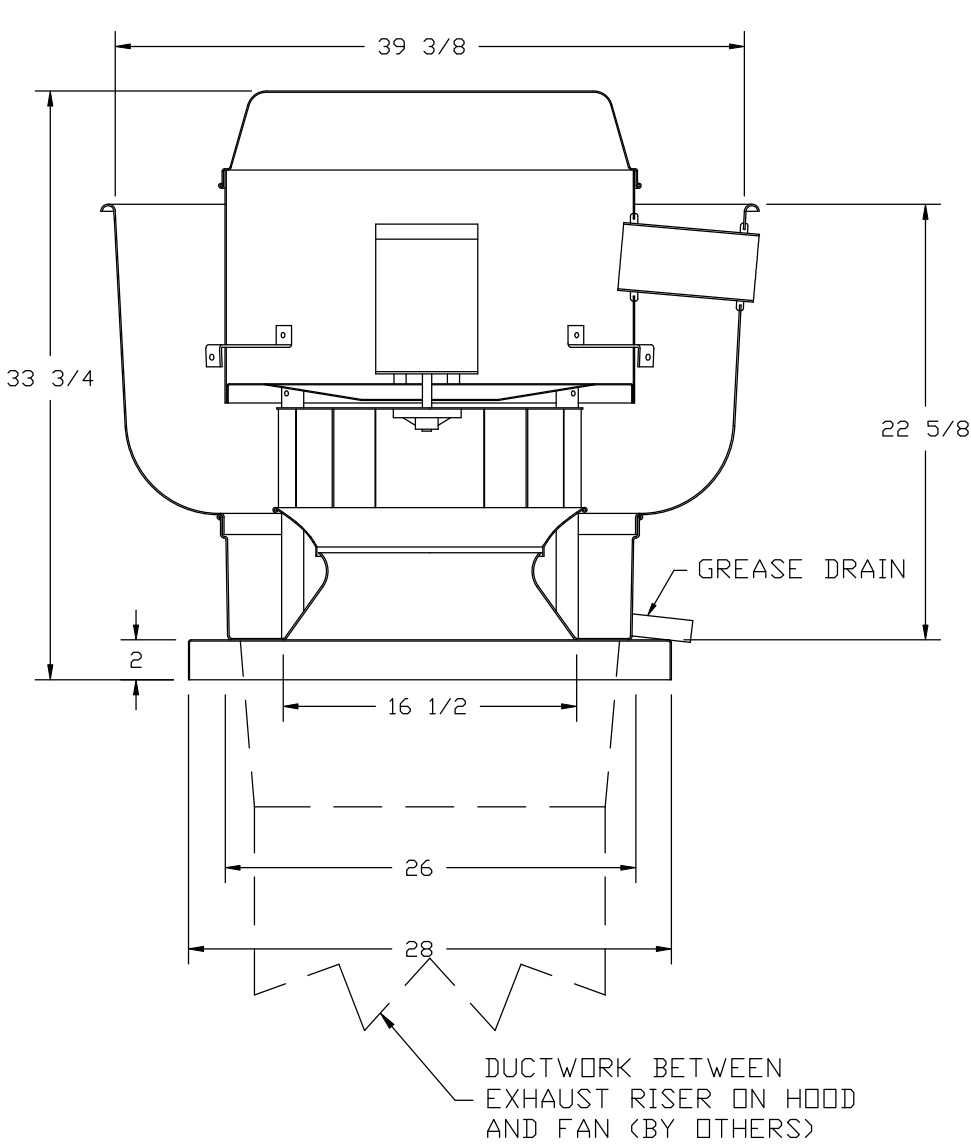
FAN ACCESSORIES

FAN UNIT NO	TAG	EXHAUST			SUPPLY								
		GREASE CUP	GRAVITY DAMPER	WALL MOUNT	SIDE DISCHARGE	GRAVITY DAMPER	MOTORIZED DAMPER	WALL MOUNT					
1		YES					YES						
2													

CURB ASSEMBLIES

NO	DN FAN	WEIGHT	ITEM	SIZE
1	# 1	41 LBS	Curb	26.500"W x 26.500"L x 20.000"H Right Vented Hinged
2	# 2	29 LBS	Curb	21.000"W x 21.000"L x 15.000"H Right

FAN #1 DUI80HFA - EXHAUST FAN



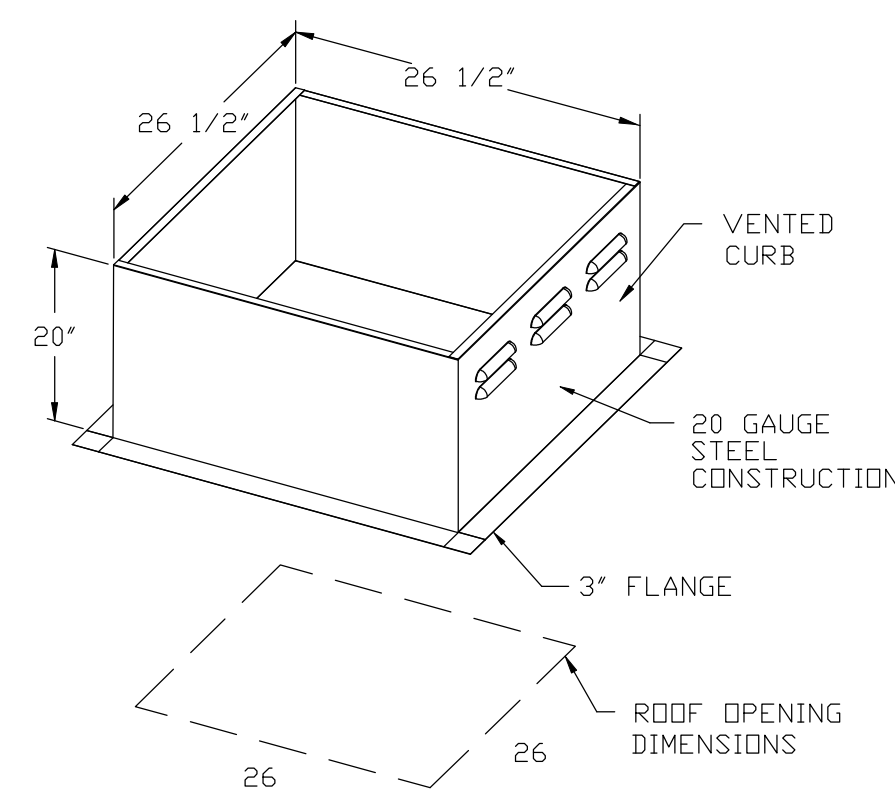
FEATURES:

- DIRECT DRIVE CONSTRUCTION (NO BELTS/PULLEYS)
- ROOF MOUNTED FANS
- RESTAURANT MODEL
- UL705 AND UL762 AND ULC-S645
- VARIABLE SPEED CONTROL
- INTERNAL WIRING
- WEATHERPROOF DISCONNECT
- THERMAL OVERLOAD PROTECTION (SINGLE PHASE)
- HIGH HEAT OPERATION 300°F (149°C)
- GREASE CLASSIFICATION TESTING

NORMAL TEMPERATURE TEST
EXHAUST FAN MUST OPERATE CONTINUOUSLY WHILE EXHAUSTING AIR AT 300°F (149°C) UNTIL ALL FAN PARTS HAVE REACHED THERMAL EQUILIBRIUM AND WITHOUT ANY DETERIORATING EFFECTS TO THE FAN WHICH WOULD CAUSE UNSAFE OPERATION.

ABNORMAL FLARE-UP TEST
EXHAUST FAN MUST OPERATE CONTINUOUSLY WHILE EXHAUSTING BURNING GREASE VAPORS AT 650°F (316°C) FOR A PERIOD OF 15 MINUTES WITHOUT THE FAN BECOMING DAMAGED TO ANY EXTENT THAT COULD CAUSE AN UNSAFE CONDITION.

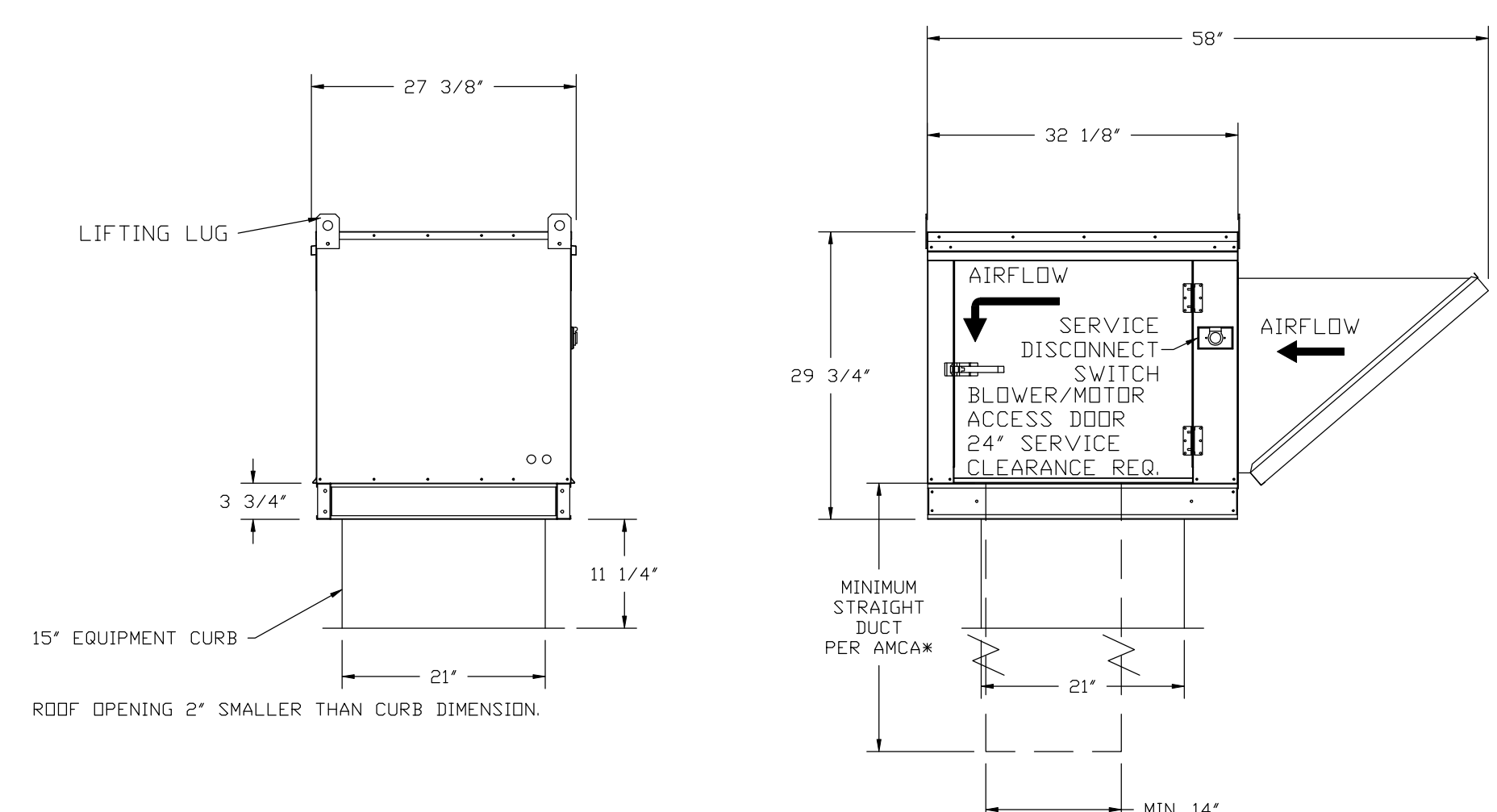
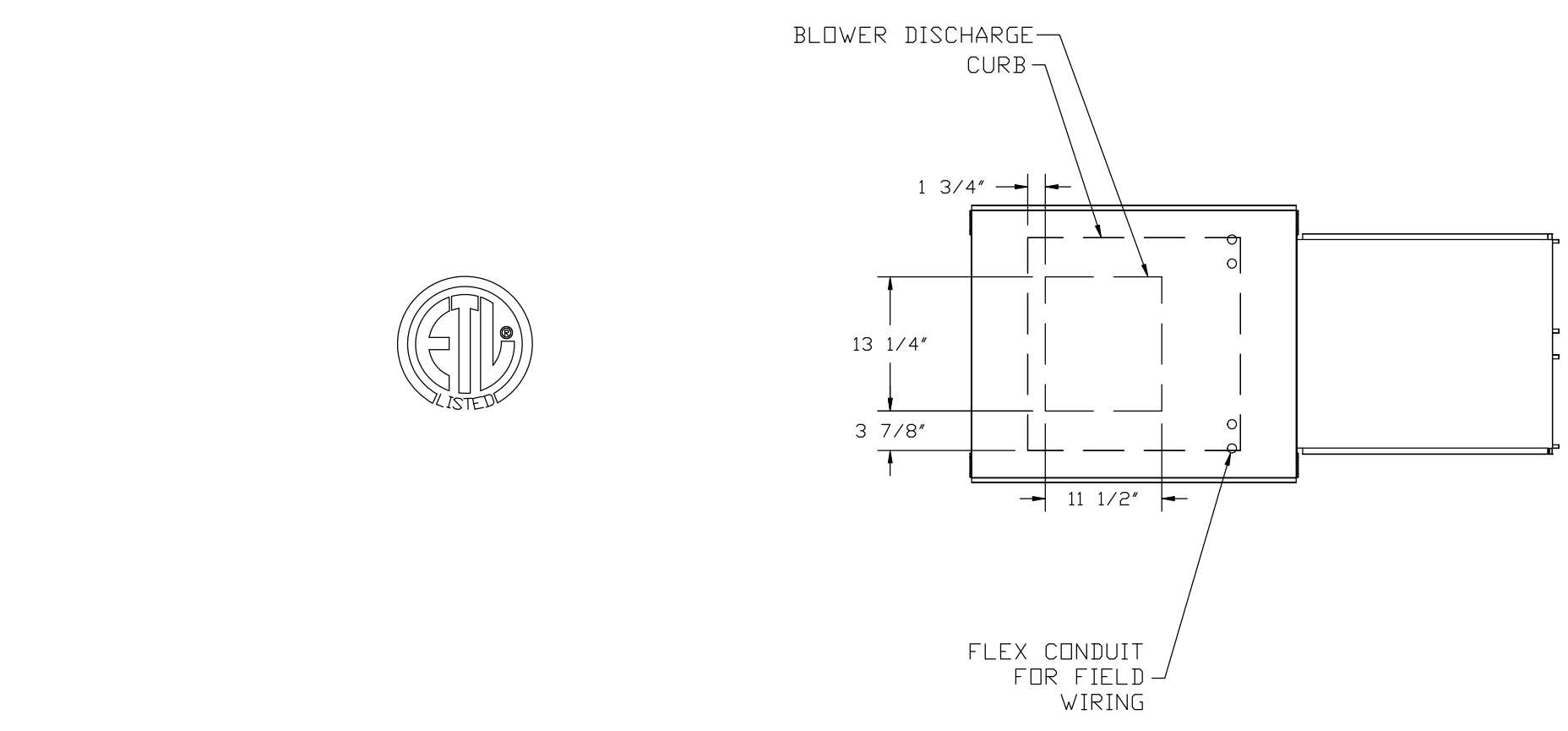
OPTIONS
GREASE BOX.



PITCHED CURBS ARE AVAILABLE FOR PITCHED ROOFS.
SPECIFY PITCH:
EXAMPLE: 7/12 PITCH = 30° SLOPE

- FAN #2 A1-15D - SUPPLY FAN
1. UNTEMPERED SUPPLY UNIT WITH 15\"/>

*NOTE: SUPPLY DUCT MUST BE INSTALLED TO MEET SMACNA STANDARDS. A MINIMUM STRAIGHT DUCT LENGTH MUST BE MAINTAINED DOWNSTREAM OF UNIT DISCHARGE AS OUTLINED IN AMCA PUBLICATION 200. WHEN USING RECTANGULAR DUCTWORK, ELBOWS MUST BE RADIUS THROAT, RADIUS BACK WITH TURNING VANES. FLEXIBLE DUCTWORK AND SQUARE THROAT/SQUARE BACK ELBOWS SHOULD NOT BE USED. ANY TRANSITION AND/OR TURNS IN THE DUCTWORK WILL CAUSE SYSTEM EFFECT. SYSTEM EFFECT WILL DRAMATICALLY INCREASE STATIC PRESSURE AND REDUCE AIRFLOW. DO NOT RELY ON UNIT TO SUPPORT DUCT IN ANY WAY. FAILURE TO PROPERLY SIZE DUCTWORK MAY CAUSE SYSTEM EFFECTS AND REDUCE PERFORMANCE OF THE EQUIPMENT. SUGGESTED STRAIGHT DUCT SIZE IS 14\"/>



PITCHED CURBS ARE AVAILABLE FOR PITCHED ROOFS.
SPECIFY PITCH:
EXAMPLE: 7/12 PITCH = 30° SLOPE

REVISIONS

NO	DESCRIPTION	DATE

CAPTIVE AIR
Houston Mechanical
www.captiveair.com
2700 Post Oak Blvd, 21st Floor, Houston, TX, 77056 PHONE: (281) 530-2007 FAX: (281) 516-8746 EMAIL: reg10@captivair.com

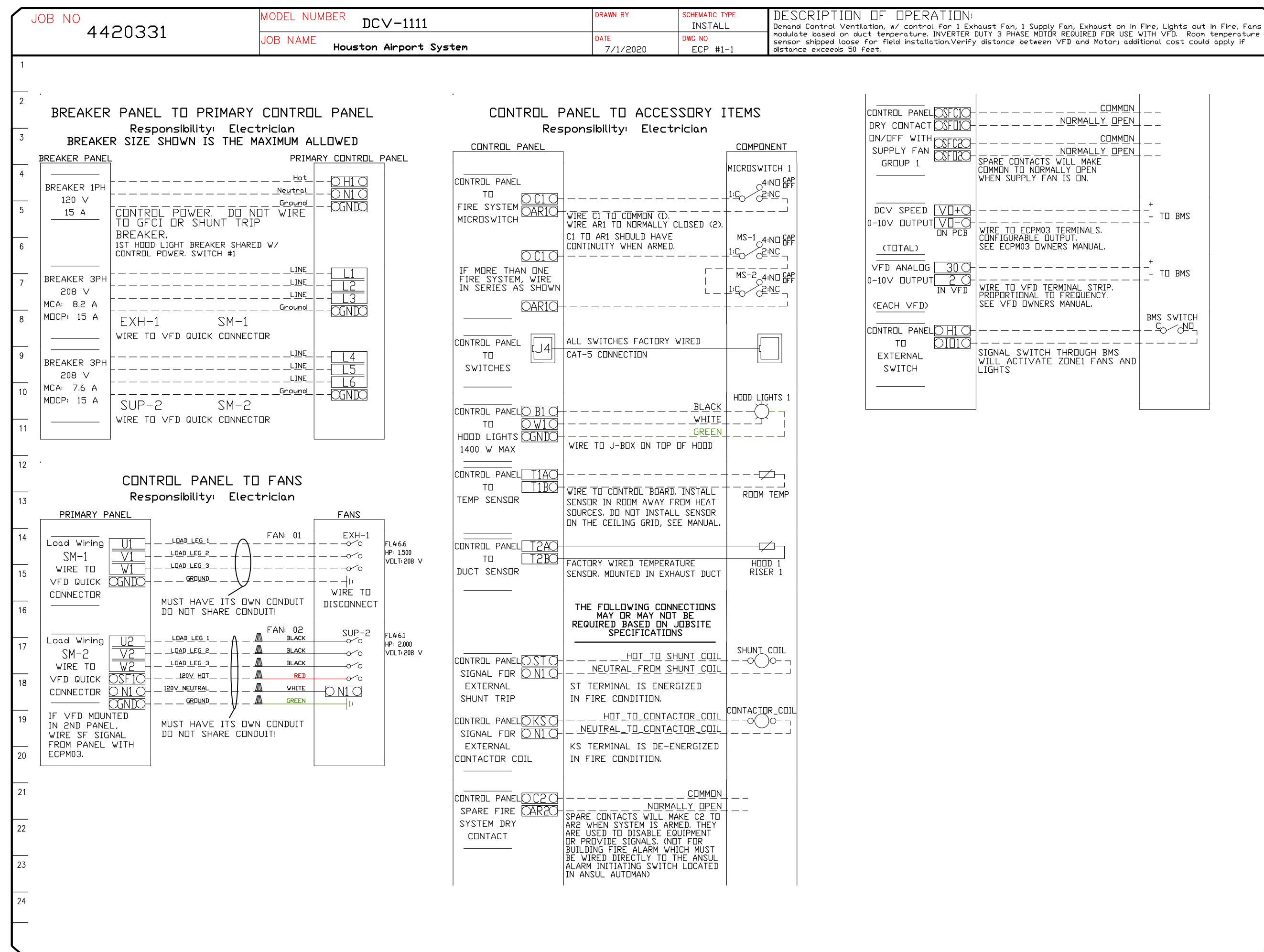
Houston Airport System
HOUSTON, TX, 77061

DATE: 7/1/2020
DWG.#: 4420331
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SCALE: 3/4" = 1'-0"
MASTER DRAWING

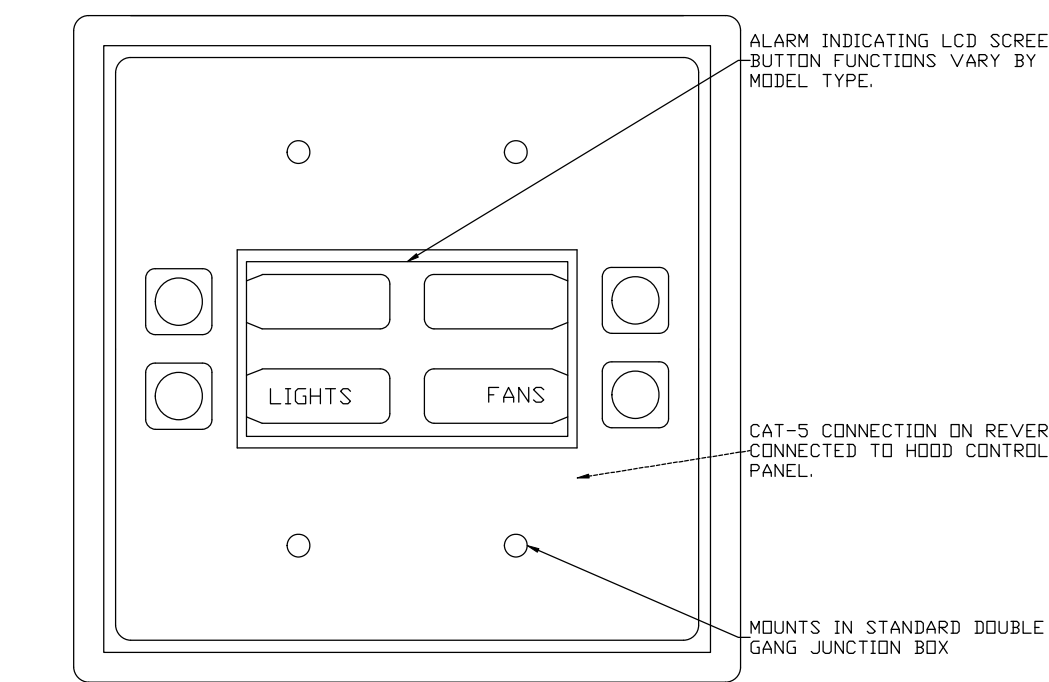
SHEET NO. 2

ELECTRICAL PACKAGE - Job#4420331

NO	TAG	PACKAGE #	LOCATION	SWITCHES		OPTION	FANS CONTROLLED				
				LOCATION	QUANTITY		TYPE	HP	VFLT	FLA	
1		DCV-1111	Utility Cabinet Right	04 - Utility Cabinet Right Hood # 1	1 Light 1 Fan	Smart Controls DCV	Exhaust	3	1,500	208	6.6
							Supply	3	2,000	208	6.1

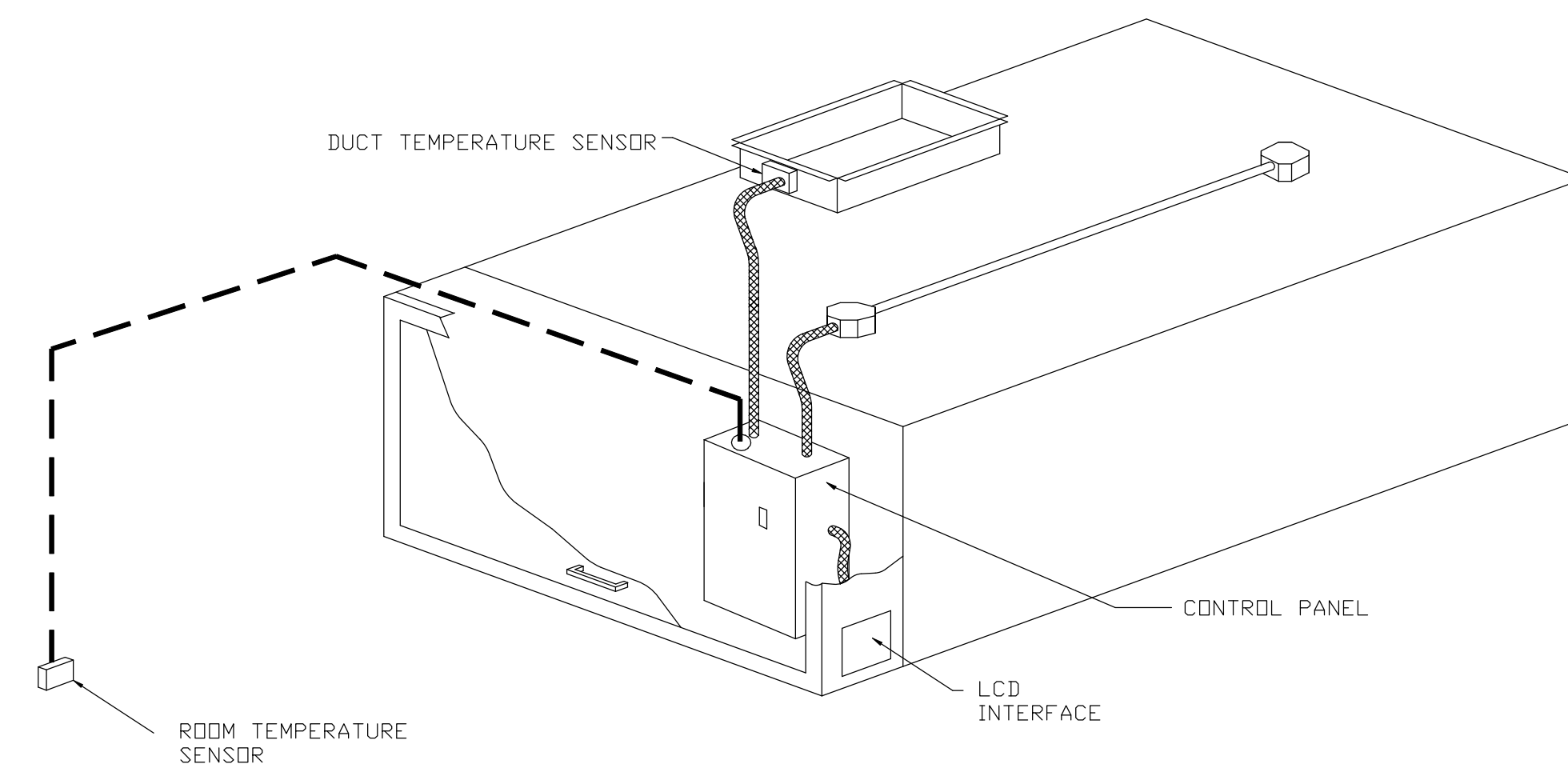


ELECTRICAL PACKAGE INTERFACE



Demand Control Ventilation Hood Control Panel Specifications:

- Controls shall be listed by ETL (UL 508A) and shall comply with demand ventilation system shutdown requirements outlined in IECC 403.2.8 (2015).
- The control enclosure shall be NEMA 1 rated and listed for installation inside of the exhaust hood utility cabinet. The control enclosure may be constructed of stainless steel or painted steel.
- Temperature probe(s) located in the exhaust duct riser(s) shall be constructed of stainless steel.
- A digital controller shall be provided to activate the hood exhaust fans dynamically based on a fixed differential between the ambient and duct temperatures sensors. This function shall meet the requirements of IMC 507.1.1.
- A digital controller shall provide adjustable hysteresis settings to prevent cycling of the fans after the cooking appliances have been turned off and/or the heat in the exhaust system is reduced.
- A digital controller shall provide an adjustable minimum fan run-time setting to prevent fan cycling.
- Variable Frequency Drives (VFDs) shall be provided for fans as required. The digital controller shall modulate the VFDs between a minimum setpoint and a maximum setpoint on demand. The duct temperature sensor input(s) to the digital controller shall be used to calculate the speed reference signal.
- The VFD speed range of operation shall be from 0% to 100% for the system, with the actual minimum speed set as required to meet minimum ventilation requirements.
- An internal algorithm to the digital controller shall modulate supply fan VFD speed proportional to all exhaust fans that are located in the same fan group as the supply fan.
- The system shall operate in PREP MODE during light cooking load or COOL DOWN MODE when sufficient heat remains underneath the hood system after cooking operations have completed. Operation during either of these periods will disable the supply fans and provide an exhaust fan speed that is equal to the minimum ventilation requirement.
- A digital controller shall disable the supply fan(s), activate the exhaust fan(s), activate the appliance shunt trip, and disable an electric gas valve automatically when fire condition is detected on a covered hood.
- A digital controller shall allow for external BMS fan control via Dry Contact (external control shall not override fan operation logic as required by code).
- An LCD interface shall be provided with the following features:
 - a. On/Off push button fan & light switch activation
 - b. Integrated gas valve reset for electronic gas valves (no reset relay required)
 - c. VFD Fault display with audible & visual alarm notification
 - d. Duct temperature sensor failure detection with audible & visual alarm notification
 - e. Mis-wired duct temperature sensor detection with audible & visual alarm notification
 - f. A single low voltage Cat-5 RJ45 wiring connection
 - g. An energy savings indicator that utilizes measured kWh from the VFDs



TYPICAL HOOD CONTROL PANEL INSTALLATION

Sequence of Operations:

- The hood control panel is capable of operating in one or more of the following states at any given time:
- **Automatic:** The system operates based on the differential between room temperature and the temperature at the hood cavity or exhaust duct collar. Fans activate at a configurable temperature differential threshold. Depending on the job configuration each fan zone can be configured as static or dynamic. These terms refer to whether a variable motor (such as EC Motors or VFD driven motors) modulate with temperature. If the panel is equipped with variable speed fans and the zone is defined as "dynamic", these will modulate within a user-defined range based on the temperature differential. Panels equipped with variable speed fans and a fan zone defined as "static", fans will run at a set speed calculated for the drive. Demand control ventilation systems are capable of modulating exhaust and make up air fan speeds per the requirements outlined in IECC 403.2.8.
 - **Manual:** The system operates based on human input from an HMI.
 - **Schedule:** A weekly schedule can be set to run fans for a specified period throughout the day. There are three occupied times per day to allow for the user to set up a time that is suitable to their needs. Any time that is within the defined occupied time, the system will run at modulation mode and follow the fan procedure algorithm based on temperature during this time. During unoccupied time, the system will have an extra offset to prevent unintended activation of the system during a time where the system is not being occupied.
 - **Interlock:** The system operates based on the input from an external source (DDC, BMS or hard-wired interlock)

REVISIONS
 DESCRIPTION DATE
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 Houston Mechanical
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 HOUSTON, TX, 77061

DATE: 7/1/2020
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SCALE: 3/4" = 1'-0"
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SHEET NO.
 3

SH, MP & HP SERIES HEAVY DUTY HOSE REELS

1/4" - 3/4" I.D.



Double axle support with Super Hub™

COXREELS® SH Series “Super Hub™” spring driven hose reels, like the P Series, have a long history of dependable performance. The larger chassis and frame accommodate longer lengths and larger diameters of hose. Coxreels’ original Super Hub™ dual axle support system increases the stability during operation, reduces vibration and strengthens the structural integrity of the reel.

SH, MP & HP SERIES

Do not exceed listed hose O.D. to obtain maximum length.

HOSE							LESS HOSE		SIZE INDEX	
MODEL	I.D.	O.D.	FT.	PSI	APRX. LBS.	EZ-COIL MODELS	MODEL	APRX. LBS.		
LOW PRESSURE							Models with hose are for air water service with a maximum temperature 150°F. Models less hose can be used for air, water or oil.			
SH-N-160	1/4"	1/2"	60	300	50	-	SHL-N-160	45	1	
SH-N-350	3/8"	5/8"	50	300	50	EZ-SH-350	SHL-N-350	44	2	
SH-N-360	3/8"	5/8"	60	300	53	-	SHL-N-360	46	2	
SH-N-375	3/8"	5/8"	75	300	68	EZ-SH-375	SHL-N-375	59	3	
SH-N-3100	3/8"	5/8"	100	300	71	EZ-SH-3100	SHL-N-3100	60	3	
SH-N-435	1/2"	3/4"	35	300	49	-	SHL-N-435	43	2	
SH-N-440	1/2"	3/4"	40	300	52	-	SHL-N-440	45	2	
SH-N-450	1/2"	3/4"	50	300	54	EZ-SH-450	SHL-N-450	46	2	
SH-N-475	1/2"	3/4"	75	300	68	EZ-SH-475	SHL-N-475	57	4	
SH-N-4100	1/2"	3/4"	100	300	81	EZ-SH-4100	SHL-N-4100	66	4	
SH-N-525	3/4"	1 1/16"	25	300	52	EZ-SH-525	SHL-N-525	45	5	
SH-N-535	3/4"	1 1/16"	35	300	57	-	SHL-N-535	47	5	
SH-N-550	3/4"	1 1/16"	50	300	69	EZ-SH-550	SHL-N-550	56	6	
MEDIUM PRESSURE							Reels are furnished with standard one wire braid hose suitable for air, water or oil applications. Hose exceeds SAE R1 specifications. Maximum Temperature 250°F.			
MP-N-340	3/8"	1 1/16"	40	3,000	63	-	MPL-N-340	53	2	
MP-N-350	3/8"	1 1/16"	50	3,000	65	EZ-MP-350	MPL-N-350	53	2	
MP-N-435	1/2"	1 3/16"	35	2,500	61	-	MPL-N-435	51	2	
MP-N-440	1/2"	1 3/16"	40	2,500	62	-	MPL-N-440	51	2	
MP-N-450	1/2"	1 3/16"	50	2,500	67	EZ-MP-450	MPL-N-450	53	7	
MP-N-525	3/4"	1 1/16"	25	1,500	61	-	MPL-N-525	51	5	
MP-N-535	3/4"	1 1/16"	35	1,500	68	-	MPL-N-535	54	5	
HIGH PRESSURE							Reels are furnished standard with S.A.E. 100R16 #1 or #2 wire braid hose suitable for grease and hydraulic oil applications. Maximum Temperature 250°F.			
HP-N-140	1/4"	9/16"	40	5,000	62	-	HPL-N-140	53	7	
HP-N-150	1/4"	9/16"	50	5,000	64	EZ-HP-150	HPL-N-150	53	7	
HP-N-160	1/4"	9/16"	60	5,000	70	-	HPL-N-160	56	7	
HP-N-335	3/8"	1 1/16"	35	4,000	61	-	HPL-N-335	52	7	
HP-N-340	3/8"	1 1/16"	40	4,000	64	-	HPL-N-340	54	7	
HP-N-350	3/8"	1 1/16"	50	4,000	65	EZ-HP-350	HPL-N-350	53	8	

To order EZ-Coil® equipped models less hose, please add prefix "EZ-"

SH, MP & HP SERIES :: REEL SPECIFICATIONS

- SWIVEL**
- External fluid path with machined from solid brass 90° full-flow NPT swivel inlet (Zinc plated steel swivel on HP models)
 - Swivel Seals: NITRILE

- DESIGN & STRUCTURE**
- Sturdy single pedestal reel features Coxreels’ exclusive Super Hub™ dual axle support system
 - Guide arm adjusts to wall, floor, vehicle & overhead positions
 - Solid one piece, heavy gauge 1/4" steel base & support post for maximum stability
 - 1" solid steel axle & lubricated precision bearings for smooth rotation

- RETRACTION**
- Controlled retraction speed up to 80% slower on EZ-COIL models :: See page 7 for details
 - Enclosed factory tuned & matched cartridge-style spring motor
 - Non-corrosive stainless steel spring, pawl & zinc plated ratchet
 - Multi-position lock ratchet mechanism secures hose at desired length

- SIGNATURE FEATURES**
- Professional grade heavy duty steel construction
 - Durable proprietary CPC™ powder coat process
 - Rolled edges & ribbed discs provide strength & safety
 - Leading 2-year manufacturer’s limited warranty
 - Made in the U.S.A. - Sold & Supported Worldwide

- POSSIBLE FIELDS OF APPLICATION**
- Air/Water Services
 - Pneumatic Tools
 - Washdown
 - Lubrication
 - Service / Mechanic / Utility Vehicles
 - Chemical Fluid Transfer
 - General Industrial
 - Manufacturing Plants & Facilities
 - Maintenance, Repair & Operations
 - Automotive & Fleet Service Centers

- ACCESSORIZE YOUR REEL :: PG 56**
- O-Rings & Swivels
 - Mounting Brackets
 - Hoses
 - Assorted Reel Accessories

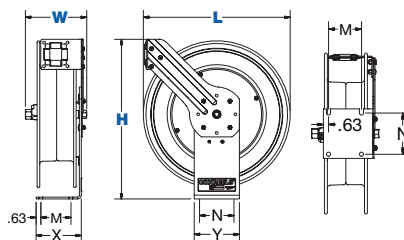
WARNING: Cancer and reproductive Harm – See page 63 for more information – www.P65Warning.ca.gov

REEL DIMENSIONS

Technical Data Sheets Available On Website

SIZE INDEX	W	H	L	X	Y	M	N
1	7 5/8"	21 1/4"	19 1/2"	6"	6"	4"	5"
2	8 1/4"	21 1/4"	19 1/2"	6"	6"	4"	5"
3	8 1/4"	25 1/2"	24"	6"	6"	4"	5"
4	8 3/4"	25 1/2"	24"	6"	6"	4"	5"
5	9 3/8"	21 1/4"	19 1/2"	6"	6"	4"	5"
6	9 7/8"	25 1/2"	24"	6"	6"	4"	5"
7	8 3/4"	21 1/4"	19 1/2"	6"	6"	4"	5"
8	9 1/4"	21 1/4"	19 1/2"	6"	6"	4"	5"

Overall Dimensions Base Mounting Pattern



**PAVEMENT DESIGN REPORT
AIRCRAFT RESCUE AND FIRE FIGHTING STATION (ARFF) #81
HOUSTON HOBBY AIRPORT (HOU)
HOUSTON, TEXAS**

**SUBMITTED TO
JACOBS
5985 Rogerdale Road
Suite 900
Houston, TX 77072**

**BY
HVJ ASSOCIATES, INC.
Austin, Texas
December 10, 2020**

**FOR
HOUSTON AIRPORT SYSTEM (HAS)
Houston, Texas**

REPORT NO. HG 17 10320.2.2





1701 Directors Boulevard, Suite 910

Austin, Texas 78744

737-222-5151

www.hvj.com

December 10, 2020

Ms. Laura Zarea, LEED AP BD+C, Project Manager
Buildings, Infrastructure & Advanced Facilities
Jacobs
5985 Rogerdale Road
Houston, Texas 77072

Re: Pavement Design Report
Aircraft Rescue and Fire Fighting (ARFF) Station #81
Hobby Airport (HOU)
Houston, Texas
Owner: Houston Airport Systems (HAS)
HVJ Report No.: HG1710320.2.2

Dear Ms. Zarea:

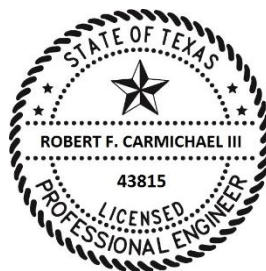
Submitted herein is the final pavement design report for the above referenced project. The study was performed in accordance with HVJ Proposal Number HG1710320.2.2 dated August 19, 2019 and subject to the limitations presented in this report.

It has been a pleasure to work for you on this project and we appreciate the opportunity to be of service. Please notify us if there are questions or if we may be of further assistance.

Sincerely,

HVJ ASSOCIATES, INC.
Texas Firm Registration No. F-000646

A handwritten signature in blue ink that reads 'R. F. Carmichael III'.



R. F. (Frank) Carmichael III, PE
Senior Project Manager

Copies submitted: 1 (electronic)

The seal appearing on this document was authorized by R. F. Carmichael III, PE 43815 on December 10, 2020. Alteration of a sealed document without proper notification to the responsible engineer is an offense under the Texas Engineering Practice Act. It is not to be used for construction, bidding or permit purposes.

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4. DESIGN CRITERIA AND PERFORMANCE CONSTRAINTS	4
5. DESIGN RESULTS.....	4
6. PREPARATION OF SUBGRADE AND GRAVEL SURFACE	5
7. LIMITATIONS.....	6

Exhibits

	<u>Exhibit</u>
DARWIN OUTPUTS	A

1. GENERAL PROJECT INFORMATION

The project involves reconstruction of the firetruck driveway for the Aircraft Rescue and Fire Fighting (ARFF) Station #81 at Houston Hobby Airport (HOU) and the employee parking lot located on Paul B. Koonce Street and west of Randolph Street in Houston, Texas. Based on the estimated traffic data, subgrade information and other pavement thickness design inputs, HVJ designed the following section options which is presented further in this report.

- ARFF firetruck driveway:
 - PCC Over Hot Mix Asphalt Concrete Base (HMAC)
 - PCC Over Cement Treated Base (CTB)

- Employee parking:
 - PCC Over Recycled Crushed Concrete Base
 - Hot Mix Asphalt Concrete (HMAC)

The DARWin¹ computer program, based on the 1993 AASHTO Pavement Design Guide², was used for the pavement thickness design. The City of Houston Standard Specifications³ were followed for the local pavement design standards. The design inputs required include design and performance constraints, traffic estimates, pavement construction material strength inputs, and insitu subgrade soil strength. The pavement evaluation and design results are summarized in following paragraphs.

2. SUBGRADE STRENGTH ESTIMATION

Based on the general soil classification for the subgrade in the project borings as shown in the Geotechnical Investigation Report⁴, the site generally consists of low plasticity sandy cohesive soil and cohesionless soil within top 5 feet. The summary of geotechnical test results is shown in the table below. It was seen that the average plasticity index of the soil found in the project area was 25.6 with percentage passing sieve No. 200 to be 69.1%.

Table 2-1: Laboratory Test Results for Subgrade Soil

Boring	Plasticity Index	% Passing #200	Soil Type
B-1	20	62.4	CL
B-2	25	54.9	CL
B-3	19	71.3	CL
B-4	25	61.6	CL
B-5	25	65.8	CL
B-6	-	-	-
B-7	16	71.1	CL

¹ AASHTOWare DARWin 3.1 – American Association of State Highway and Transportation Officials, 1991-2009

² AASHTO Design of Pavement Structures, American Association of State Highway and Transportation Officials, 1993.

³ Standard Construction Specifications, City of Houston Department of Public Works and Engineering, 2017

⁴ Geotechnical Investigation, ARFF # 81 at Houston Hobby (HOU), HVJ Associates®, September 2020 (Draft)

Boring	Plasticity Index	% Passing #200	Soil Type
B-8	-	-	-
B-9	-	-	-
B-10	24	74	CL
B-11	44	73.1	CH
B-12	24	74.2	CL
B-13	22	72.8	CL
B-14	17	67.4	CL
B-15	46	81	CH

As seen in the table, the subgrade is fine grained soil with very low to no cohesion. The presence of water in such subgrade soil can cause the fine material to be washed away creating premature pumping in the concrete pavement. For such subgrade soil, it is recommended that at least 6.0" of subgrade should be stabilized with cement to prevent occurrence of pumping and to provide a working platform for the construction.

In addition to the Atterberg Limits and sieve analysis, the California Bearing Ratio (CBR) test was conducted on the subgrade soil sample obtained from the site. The laboratory report⁴ showed a CBR value of 1.47. The design subgrade strength was developed using the following correlation relationship between the resilient modulus of the subgrade soil and the CBR test result.

$$\text{Resilient Modulus } (R_M) = 1500 \times \text{CBR} \quad (\text{For } \text{CBR} < 10, \text{ Heukelom and Klomp, 1962})$$

Using the above relationship, the resilient modulus of the subgrade was estimated as 2,205 psi. This value was consistent with the soil type found in the project area and was used as the design subgrade resilient modulus for the pavement design. The composite modulus of subgrade reaction for the firetruck driveway was calculated using AASHTO DARWin¹ with a 4.0" of HMAC base layer and 6.0" CTB layer, with the assumed resilient modulus values of 500 ksi and 150 ksi, respectively. Both base options had loss of support of 0², which rendered values of 182 pci and 193 pci, respectively. Further, in the case of staff parking area, with the 6.0" of cement stabilized subgrade and a recycled crushed concrete base with assumed resilient modulus of 50 ksi and loss of support of 1², the composite modulus of subgrade reaction was calculated as 59 pci.

3. TRAFFIC DATA

The traffic parameters required for design include initial average daily traffic (ADT), ADT growth rate, directional and lane distribution factors, percent trucks in ADT, and average 18-kip equivalent truck factor. Based on the traffic information provided and some general assumptions, the traffic inputs were developed for the design purpose.

The types of vehicles in the average annual daily traffic (AADT) for the firetruck driveway and staff parking were provided to HVJ by Jacobs. The number of movements per day was not provided, so HVJ assumed the following daily movements, loaded weights and equivalent single axle loads (ESALs) per vehicle pass.

Vehicle Type	Gross Vehicle Weight, kips	Assumed Movements per Day, AADT	Equivalent Single Axle Loads (ESALs) per pass
Small/Fleet Vehicles (Suburban) – FHWA Class 3	7.5	6	0.002
Special Vehicles (Triage Trailer, Emergency Stairs, EMS Van Type 1) – FHWA Class 5	15.0	3	0.64
Airport Rescue and Fire Fighting (ARFF) Units (2006, 2016, 2019 Rosenbauer) – FHWA Class 6	85.0	6	22.00

After reassessing suggestions made by Jacobs and the number of parking spaces, HVJ assumed that the ARFF vehicle will have a turnover of 6 times. In case of the staff parking, the percentage trucks is assumed as 10% of ADT considering occasional emergency vehicles and fire lanes.

The heaviest vehicle (Rosenbauer) was assumed to have 65% (54.7 kips) of the load on the heaviest axle with the tandem axle and 35% (29.5 kips) load on one single axle. The rigid pavement projected slab thickness of 10 inches and terminal serviceability index of 2.5 was assumed to estimate the truck factor using the tables in the 1993 AASHTO Pavement Design Guide. The table below shows the design assumptions.

Table 3-1: Basic Traffic Data – Fire Truck Driveway

Parameter	AARF Vehicle
AARF Vehicle Gross Load	84.2 kips
Number of axles	3
Single Axle	29.5 kips
Tandem Axle	54.7 kips
Terminal Serviceability	2.5
Projected Slab thickness	10"
Truck factor	22*
ADT	6
Percentage truck \geq Class 5	100%

* Values were referred from AASHTO Design Guide, 1993

In case of the staff parking area with occasional fire trucks being of similar gross weight category, the truck factor of 1.2 was assumed with the combined single and tandem axle.

The equivalent single axle load repetitions (ESALs) was calculated using AASHTO DARWin for the design using 0% growth factor and 50 year design life. The ESAL calculated for the design of Aircraft Rescue and Fire Fighting (ARFF) Station was 2,410,650 and that for the staff parking area was 6,312.

4. DESIGN CRITERIA AND PERFORMANCE CONSTRAINTS

A rigid pavement option was designed with the DARWin computer program for the anticipated traffic levels previously described. The confidence level used for the designs is 90%. The performance period is 50 years for the ARFF Firetruck Driveway. The initial serviceability index is set at 4.5. The terminal serviceability index is set at 2.5, which is appropriate for low traffic volume less than 3,000 average daily traffic (ADT).

HVJ recommends an HMAC base to be placed beneath the PCC surface for the Aircraft Rescue and Fire Fighting (ARFF) Driveway due to heavy truck loads. The HMAC base directly under concrete would behave as a non-erodible material that will not pump subgrade fines through the concrete joints and also behave as a moisture barrier to minimize moisture fluctuations in the subgrade that may cause shrink/swell conditions.

The initial serviceability index and the final serviceability index of the concrete pavement was assumed as 4.5 and 2.5 respectively. The 28-day modulus of elasticity of 2.6×10^6 psi was assumed for the jointed cement concrete. Reliability of 90% was used for design. The load transfer coefficient was assumed as 2.9 for a JRCRCP with no tied shoulder, and the drainage coefficient was assumed as 0.8. The HMAC base modulus for design was assumed at 500 ksi.

5. DESIGN RESULTS

The DARWin design outputs for the Aircraft Rescue and Fire Fighting (ARFF) Station are included in Exhibit A of this report. The resulting 50-year pavement design options for Aircraft Rescue and Fire Fighting (ARFF) Driveway and the 20-year design options for the employee parking lot are as follows.

ARFF Driveway Portland Cement Concrete Design Options: 50 year service life

Site	HMAC Base Option	Cement Treated Base Option
Driveway ARFF	<ul style="list-style-type: none"> ▪ 9.0” Concrete Reinforced with #4 bars at 12.5” O.C.B.W. ▪ 4.0” HMAC Base Type A or Type B ▪ 8.0” Cement Stabilized Subgrade (CSS) (estimate 6% cement) 	<ul style="list-style-type: none"> ▪ 9.0” Concrete Reinforced with #4 bars at 12.5” O.C.B.W. ▪ 6.0” Cement Treated Base (CTB) ▪ 8.0” Cement Stabilized Subgrade (CSS) (estimate 6% cement)

Employee Parking Lot Portland Cement Concrete (PCC) and Hot Mix Asphalt Concrete (HMAC) Designs: 20 year service life

Site	HMAC Option	PCC Option
Parking Lot	<ul style="list-style-type: none"> ▪ 3.0” DG TY C (PG70-22) ▪ 6.0” Recycled Crushed Concrete Base ▪ 8.0” Cement Stabilized Subgrade (CSS) (est. 6% cement) 	<ul style="list-style-type: none"> ▪ 6.0” PCC* ▪ 6.0” Recycled Crushed Concrete Base ▪ 8.0” Cement Stabilized Subgrade (CSS) (est. 6% cement)

- **Since the calculated PCC design is less than the COH minimum, HVJ recommends the minimum thickness of 6”**

Material Specifications – City of Houston Material Specifications

- Item No. 20338 – Cement Stabilized Subgrade
- Item No. 02713 – Recycled Crushed Concrete Base Course
- Item No. 02742 – Prime Coat
- Item No. 02743 – Tack Coat
- Item No. 02741 – Hot Mix Asphaltic Concrete Pavement (HMA)
- Item No. 02751 – Concrete Pavement

The concrete pavement is recommended to be Jointed Reinforced Concrete Pavement (JRCP). The reinforcement and dowel bar details will be followed as per City of Houston Concrete Pavement Details – 02751-01, and Joint Details – 02752-01. Minimum required reinforcing steel strength shall be 60,000 psi

6. PREPARATION OF SUBGRADE

The surficial soils underlying the existing pavement consist of lean clays. HVJ recommends stabilizing the top 8 inches of subgrade soil beneath the pavement base with 6% cement to achieve a minimum 7 day compressive strength of 150 psi. Stabilization of the subgrade will increase the modulus of subgrade reaction and provide subgrade stability for construction during inclement weather. Subgrade stabilization will enhance long-term pavement performance by reducing the tendency of the soil to displace from beneath pavement by pumping. HVJ recommends the following procedures for subgrade preparation.

1. Clear the proposed development area of existing pavement, and foreign material within the proposed area to the grade required.
2. Surfaces exposed after excavation should be proof-rolled in accordance with COH specification. If rutting develops, tire pressures should be reduced. The purpose of the proof-rolling operation is to identify any underlying zones or pockets of weak pavement/base materials.
3. For estimating purposes for the subgrade cement stabilization, 6.0% cement per dry unit weight of soil may be assumed for cement stabilization as per COH – 02338. HVJ requires

that the assumed cement percentage amount shall be verified by laboratory testing submitted by the contractor prior to stabilization to confirm the appropriate percentage of cement during the time of construction.

7. LIMITATIONS

This study was performed for the exclusive use of Jacobs and Houston Airport Systems for specific application to the Aircraft Rescue and Fire Fighting (ARFF) Station #81 at Houston Hobby Airport. HVJ Associates, Inc. makes no warranty, express or implied. The analyses and recommendations contained in this report are based on data obtained from subsurface exploration, laboratory testing, the project information provided to us and our experience with similar soils and site conditions.

In the event that any changes in the nature, design, or location of the improvements are made, the conclusions and recommendations in this report should not be considered valid until the changes are reviewed and the conclusions and recommendations modified or verified in writing by HVJ Associates.

EXHIBIT A
DARWIN OUTPUTS

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Rigid Structural Design Module

ARFF Fire Truck Driveway
ARFF # 81 Hobby Airport (HOU)

Rigid Structural Design

Pavement Type	JPCP
18-kip ESALs Over Initial Performance Period	2,410,650
Initial Serviceability	4.5
Terminal Serviceability	2.5
28-day Mean PCC Modulus of Rupture	601 psi
28-day Mean Elastic Modulus of Slab	2,587,500 psi
Mean Effective k-value	182 psi/in
Reliability Level	90 %
Overall Standard Deviation	0.39
Load Transfer Coefficient, J	2.9
Overall Drainage Coefficient, Cd	0.8
Calculated Design Thickness	8.76 in

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

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Rigid Structural Design Module

ARFF Fire Truck Driveway
ARFF # 81 Hobby Airport (HOU)

Effective Modulus of Subgrade Reaction

<u>Period</u>	<u>Description</u>	<u>Roadbed Soil Resilient Modulus (psi)</u>	<u>Base Elastic Modulus (psi)</u>
1	1	2,205	500,000
	Base Type	HMAC	
	Base Thickness	4 in	
	Depth to Bedrock	100 ft	
	Projected Slab Thickness	10 in	
	Loss of Support Category	0	
	Effective Modulus of Subgrade Reaction	182 psi/in	

Simple ESAL Calculation

Performance Period (years)	50
Two-Way Traffic (ADT)	6
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	100 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	100 %
Average Initial Truck Factor (ESALs/truck)	22
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	0 %
Growth	Compound
Total Calculated Cumulative ESALs	2,410,650

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

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Computer Software Product

Rigid Structural Design Module

ARFF Fire Truck Driveway
ARFF # 81 Hobby Airport (HOU)

Rigid Structural Design

Pavement Type	JPCP
18-kip ESALs Over Initial Performance Period	2,410,650
Initial Serviceability	4.5
Terminal Serviceability	2.5
28-day Mean PCC Modulus of Rupture	601 psi
28-day Mean Elastic Modulus of Slab	2,587,500 psi
Mean Effective k-value	193 psi/in
Reliability Level	90 %
Overall Standard Deviation	0.39
Load Transfer Coefficient, J	2.9
Overall Drainage Coefficient, Cd	0.8
Calculated Design Thickness	8.72 in

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

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Computer Software Product

Rigid Structural Design Module

ARFF Fire Truck Driveway
ARFF # 81 Hobby Airport (HOU)

Effective Modulus of Subgrade Reaction

<u>Period</u>	<u>Description</u>	<u>Roadbed Soil Resilient Modulus (psi)</u>	<u>Base Elastic Modulus (psi)</u>
1	1	2,205	150,000
Base Type	Cement Treated Base		
Base Thickness	6 in		
Depth to Bedrock	100 ft		
Projected Slab Thickness	10 in		
Loss of Support Category	0		
Effective Modulus of Subgrade Reaction	193 psi/in		

Simple ESAL Calculation

Performance Period (years)	50
Two-Way Traffic (ADT)	6
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	100 %
Percent Trucks in Design Direction	100 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	100 %
Average Initial Truck Factor (ESALs/truck)	22
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	0 %
Growth	Compound
Total Calculated Cumulative ESALs	2,410,650

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Flexible Structural Design Module

Parking Lot
ARFF # 81 Hobby Airport (HOU)

CSJ: 0918-47-240

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	6,312
Initial Serviceability	4
Terminal Serviceability	2.5
Reliability Level	90 %
Overall Standard Deviation	0.39
Roadbed Soil Resilient Modulus	2,205 psi
Stage Construction	1
Calculated Design Structural Number	2.35 in

Simple ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	72
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	10 %
Percent Trucks in Design Direction	100 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	10 %
Average Initial Truck Factor (ESALs/truck)	1.2
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	0 %
Growth	Compound
Total Calculated Cumulative ESALs	6,312

Specified Layer Design

<u>Layer</u>	<u>Material Description</u>	Struct Coef. <u>(Ai)</u>	Drain Coef. <u>(Mi)</u>	Thickness <u>(Di)(in)</u>	Width <u>(ft)</u>	Calculated <u>SN (in)</u>
1	Hot Mix Asphalt Concrete	0.44	1	3	12	1.32
2	Recycled Crushed Concrete Base	0.14	1	6	12	0.84
3	Cement Stabilized Subgrade	0.06	1	8	12	0.48
Total	-	-	-	17.00	-	2.64

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Rigid Structural Design Module

Parking Lot
ARFF # 81 Hobby Airport (HOU)

Rigid Structural Design

Pavement Type	JPCP
18-kip ESALs Over Initial Performance Period	6,312
Initial Serviceability	4
Terminal Serviceability	2.5
28-day Mean PCC Modulus of Rupture	601 psi
28-day Mean Elastic Modulus of Slab	2,587,500 psi
Mean Effective k-value	59 psi/in
Reliability Level	90 %
Overall Standard Deviation	0.39
Load Transfer Coefficient, J	2.9
Overall Drainage Coefficient, Cd	0.8
Calculated Design Thickness	3.20 in

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Rigid Structural Design Module

Parking Lot
ARFF # 81 Hobby Airport (HOU)

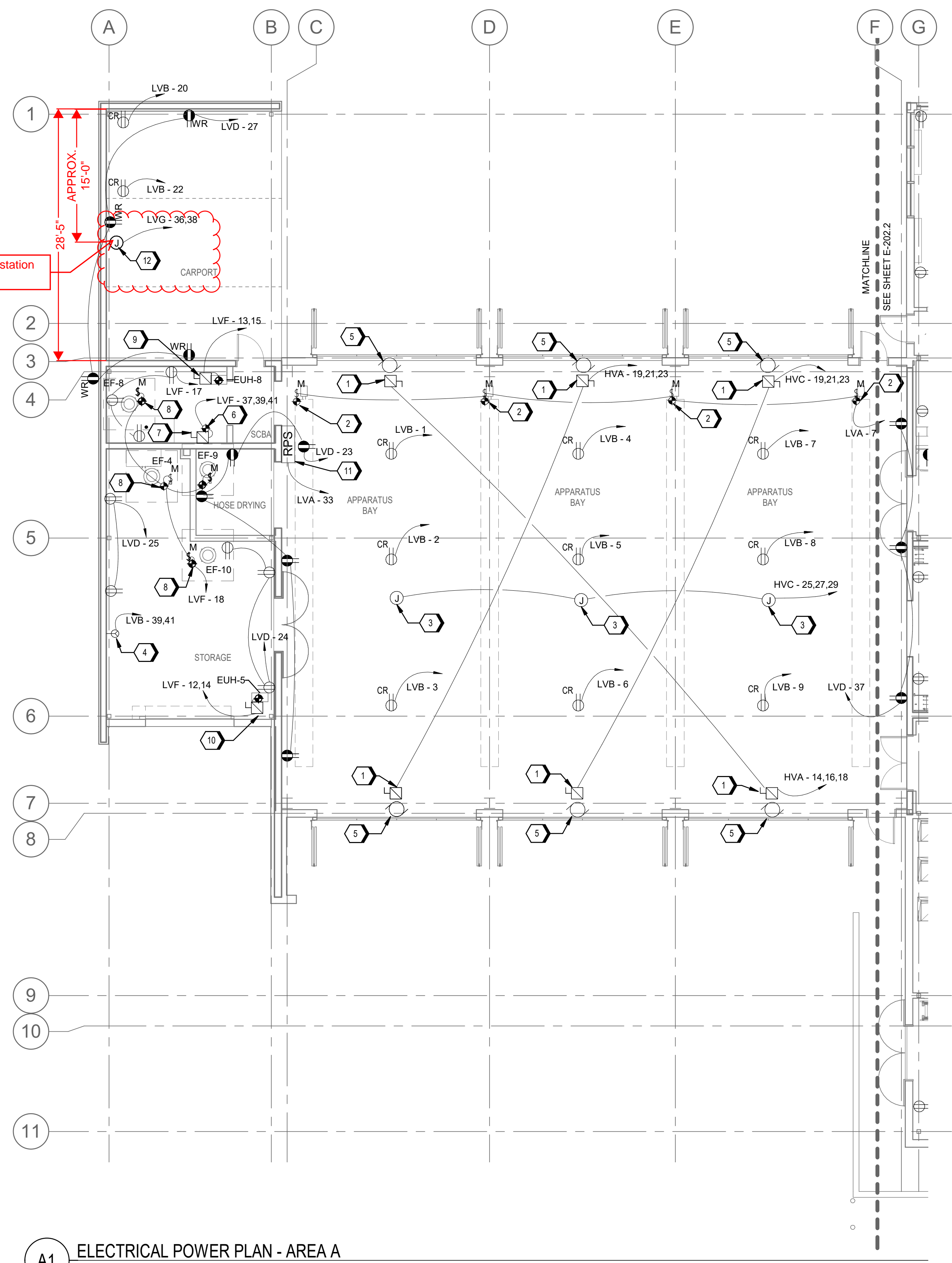
Effective Modulus of Subgrade Reaction

<u>Period</u>	<u>Description</u>	<u>Roadbed Soil Resilient Modulus (psi)</u>	<u>Base Elastic Modulus (psi)</u>
1	1	2,205	50,000
Base Type	Recycled Crushed Concrete Base		
Base Thickness	6 in		
Depth to Bedrock	100 ft		
Projected Slab Thickness	4 in		
Loss of Support Category	1		
Effective Modulus of Subgrade Reaction	59 psi/in		

Simple ESAL Calculation

Performance Period (years)	20
Two-Way Traffic (ADT)	72
Number of Lanes in Design Direction	1
Percent of All Trucks in Design Lane	10 %
Percent Trucks in Design Direction	100 %
Percent Heavy Trucks (of ADT) FHWA Class 5 or Greater	10 %
Average Initial Truck Factor (ESALs/truck)	1.2
Annual Truck Factor Growth Rate	0 %
Annual Truck Volume Growth Rate	0 %
Growth	Compound
Total Calculated Cumulative ESALs	6,312

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A1 ELECTRICAL POWER PLAN - AREA A
1/8" = 1'-0"

GENERAL NOTES

- A. REFER TO SHEET E-001.2 AND E-002.2 FOR ELECTRICAL SYMBOLS, ABBREVIATIONS, AND GENERAL NOTES.
- B. ALL CONDUIT TO BE 3/4" MINIMUM. PROVIDE WITH STEEL CONNECTORS AND COUPLINGS (INDOOR ONLY).
- C. ALL CONDUIT ROUTING IS SHOWN DIAGRAMMATICALLY.
- D. RE: E-700.2 FOR ADDITIONAL INFORMATION.

KEYED NOTES

- 1 30/3NF DISCONNECTING MEANS.
- 2 INFRARED HEATER ELECTRICAL CONNECTION.
- 3 JUNCTION BOX FOR CEILING FAN.
- 4 NEMA 5-50R RECEPTACLE. COORDINATE LOCATION WITH OWNER.
- 5 ROLL-UP DOOR. CONTROLS PROVIDED BY DOOR MANUFACTURER. OPEN-CLOSE CONTROLS SHALL BE LOCATED ADJACENT TO THE ASSOCIATED DOOR TO BE CONTROLLED.
- 6 SCBA FILL STATION.
- 7 60/3NF DISCONNECTING MEANS.
- 8 MOTORIZED DAMPER. COORDINATE ELECTRICAL CONNECTION WITH MECHANICAL.
- 9 30/2NF DISCONNECTING MEANS.
- 10 60/2NF DISCONNECTING MEANS.
- 11 ~~REMOTE POWER SUPPLY - FIRE ALARM~~
- 12 ELECTRIC VEHICLE CHARGING STATION. PROVIDE BASED ON CHARGE POINT CT4000 NEMA 3R OR APPROVED EQUAL. COORDINATE EXACT LOCATION WITH OWNER.

JACOBS
5885 Rogerdale Road
Houston, TX 77072 (281) 721-8400
www.jacobs.com
TBPE Firm #2966

REVISIONS

Mark	Date	Description
1	1/17/2020	ISSUED FOR PRICING
2	07/31/2020	60% CD
3	10/01/2020	ISSUE FOR TIP/BSG REVIEW
4	01/07/2021	75% CD
5	04/15/2021	90% ISSUE FOR BID AND PERMIT
6	04/15/2022	ISSUE FOR BID

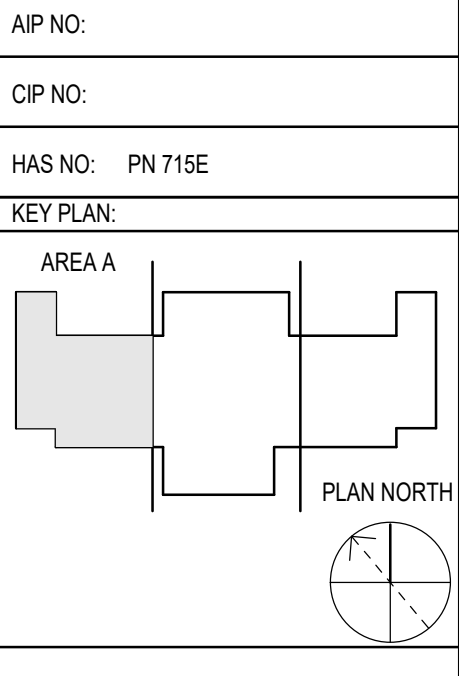
OWNER:
HOUSTON AIRPORT SYSTEM

TIP-20-219-HOU
BSG-2020-223-HOU
HOUSTON AIRPORT SYSTEM

CONSULTANT:

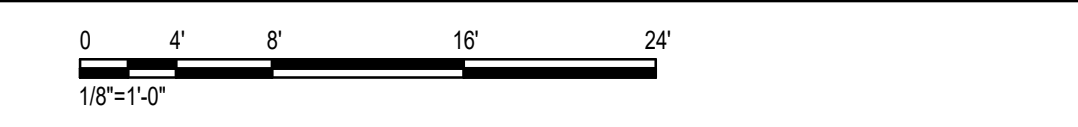


HOUSTON AIRPORT SYSTEM
PN 715E - 009
ARFF NO. 81 - PHASE 2 - 4
PACKAGE 2
7990 PAUL B. KOONCE ST.
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Jacobs Project No.: WHXX7109
Drawing Title:
ELECTRICAL POWER PLAN - AREA A
Date: 04/15/22
Designed: DHJ Drawing No.:
Drawn: GJS
Checked: HMS

GRAPHIC SCALE:



4" SANITARY FORCE
MAIN, 115 L.F.

6" SAN SEWER F.L. 36.15.
SEE PLUMBING PLANS.

PROP. SANITARY
LIFT STATION
RIM 44.65
IN FL: 35.87

1" HOSE BIB
CONNECTION
FOR SANITARY



6"

CO

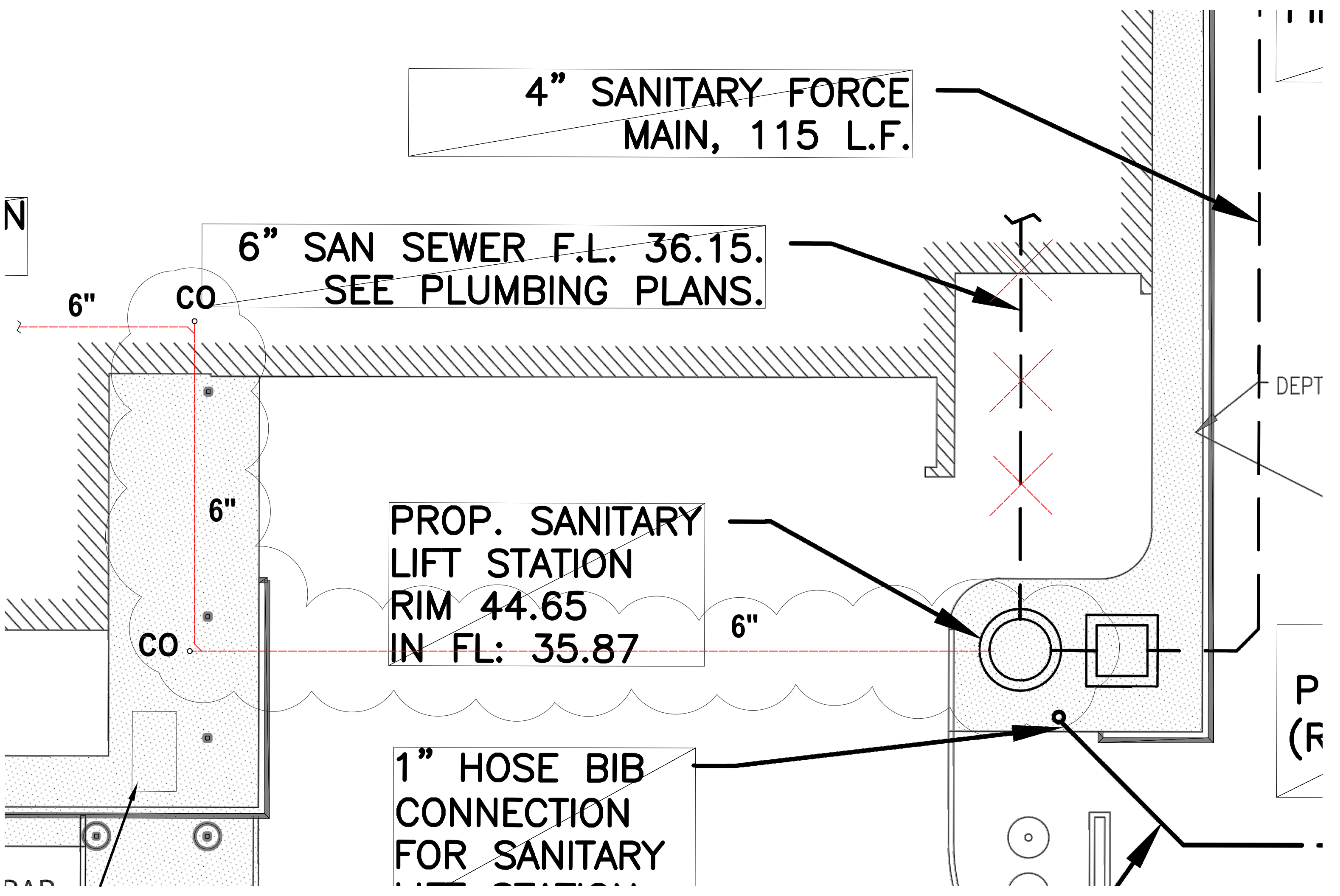
6"

CO

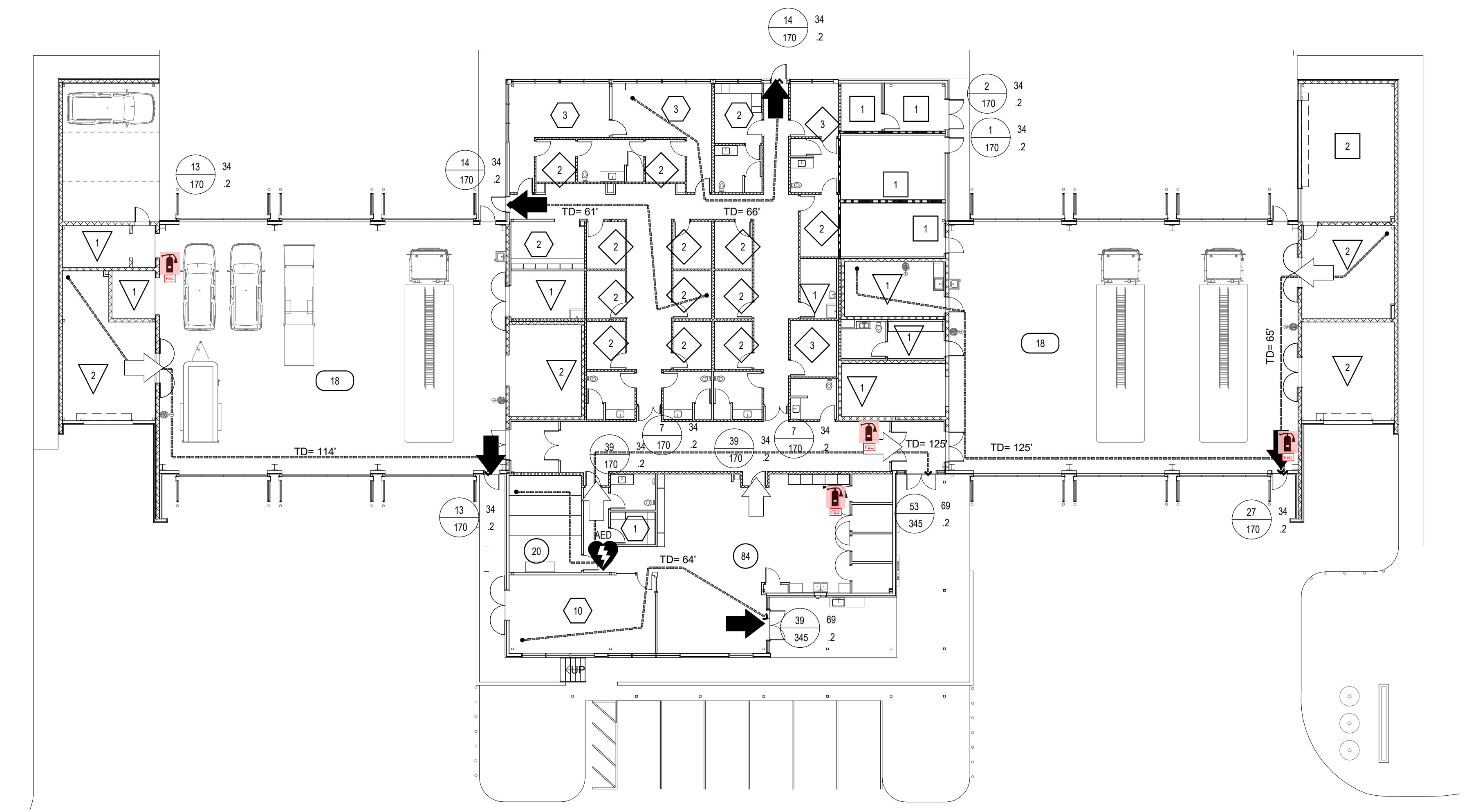
6"

DEPT

P
(R)



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1 FIRST FLOOR - LIFE SAFETY PLAN
1/16" = 1'-0"

LIFE SAFETY GENERAL NOTES

- A. ENSURE THE CONTINUITY AND MAINTAIN THE PRIORITY OF RATED ASSEMBLIES AND SMOKE ASSEMBLIES THAT ARE INDICATED.
- B. PROVIDE THROUGH PENETRATION FIRE STOPPING SYSTEM AT ALL PENETRATIONS THROUGH RATED PARTITIONS. REFERENCE PARTITION TYPES, WHERE A PARTITION IS INDICATED TO BE FIRE RATED PROVIDE THROUGH PENETRATION FIRESTOPPING SYSTEM CONSTRUCTED IN STRICT COMPLIANCE WITH THE FIRE TEST DESIGN (TESTED AND COMPATIBLE WITH LEVEL OF RATING INDICATED) AT ALL PENETRATIONS. IF NO TEST IS REFERENCED, PROVIDE AN INDUSTRY RECOGNIZED FIRE TEST COMPATIBLE WITH PARTITION CONSTRUCTION AND REFERENCE DISCIPLINE SHEETS FOR PENETRATION LOCATIONS.
- C. REFERENCE ELECTRICAL AND FIRE PROTECTION SHEETS FOR LOCATION OF FIRE ALARM NOTIFICATION DEVICES, MANUAL FIRE ALARM BOXES, PULL STATIONS AND EXIT SIGNAGE.
- D. FOR EMERGENCY LIGHTING AND ILLUMINATED EXIT SIGNAGE, REFERENCE ELECTRICAL.
- E. RATED PARTITIONS AROUND COLUMNS SHALL MAINTAIN ADJOINING FIRE RATED ENVELOPE.
- F. PORTABLE FIRE EXTINGUISHERS SHALL BE INSTALLED IN ACCORDANCE WITH NFPA 10.
- G. INSTALL FIRE ALARM PULL STATION SIGN AT EACH FIRE ALARM STATION AND FIRE EXTINGUISHER SIGN AT FIRE EXTINGUISHER. FIRE PULL STATIONS TO BE LOCATED AT ALL ACCESS CONTROLLED DOORS OF ENTRY.
- H. PROVIDE MARKING AND IDENTIFICATION OF FIREWALLS, FIRE BARRIERS, FIRE PARTITIONS, SMOKE BARRIERS AND SMOKE PARTITIONS WITH PERMANENTLY IDENTIFIED SIGNS OR STENCILING IN THE CONCEALED SPACE IN FULL COMPLIANCE WITH SECTION 703.7 OF THE 2012 INTERNATIONAL BUILDING CODE. SIGNS/STENCILING SHALL BE LOCATED WITHIN 15 FEET OF THE END OF EACH WALL AND AT INTERVALS NOT EXCEEDING 30 FEET MEASURED HORIZONTALLY ALONG THE WALL OR PARTITION. LETTERING SHALL NOT BE LESS THAN 3 INCHES IN HEIGHT WITH A MINIMUM 3/8 INCH STROKE IN A CONTRASTING COLOR. WHERE NO CONCEALED FLOOR, FLOOR-CEILING SPACE OCCURS, PLACE SIGN/STENCILING AT UPPERMOST VISIBLE AREA OF PARTITION.



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Mark	Date	Description
1	1/17/2020	ISSUED FOR PRICING
2	07/31/2020	60% CD
3	10/01/2020	ISSUE FOR TIP/BSG REVIEW
4	01/07/2021	75% CD
5	04/15/2021	90% ISSUE FOR BID AND PERMIT
6	04/15/2022	ISSUE FOR BID

OWNER:
HOUSTON AIRPORT SYSTEM
TIP-20-219-HOU
BSG-2020-223-HOU
HOUSTON AIRPORT SYSTEM

CONSULTANT:



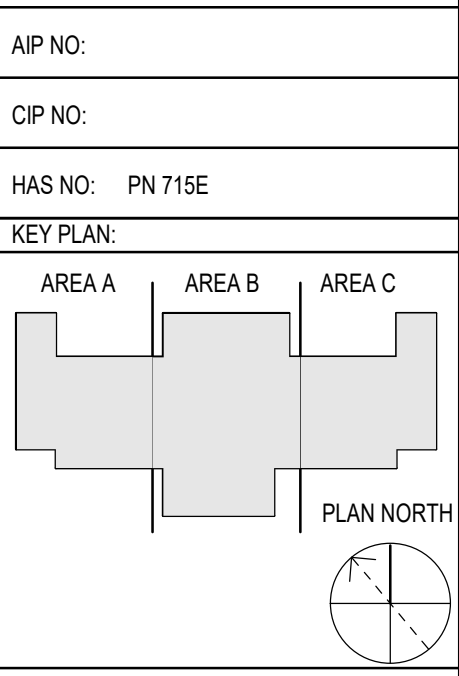
LIFE SAFETY PLAN LEGEND

- INDICATES 1-HOUR FIRE PARTITIONS
- INDICATES 2-HOUR FIRE RATED CMU
- W = CLEAR WIDTH OF LIMITING COMPONENT (m)
X = OCCUPANTS USING EXIT
Y = EXIT CAPACITY
Z = EGRESS WIDTH PER OCCUPANT (m/PERSON) (NFPA TABLE 7.3.3.1)
- TD = XX' TRAVEL DISTANCE
- FIRE EXTINGUISHER LOCATION (FE CFCI)
- AUTOMATED EXTERNAL DEFIBRILATOR (CFCI)
- EXIT DISCHARGE AT EXTERIOR
- EXIT ROUTE / DISCHARGE INSIDE THE BUILDING

MAXIMUM NUMBER OF OCCUPANTS ACCORDING TO OCCUPANCY (IBC TABLE 1004.1.1) (NFPA 101 TABLE 7.3.1.2)

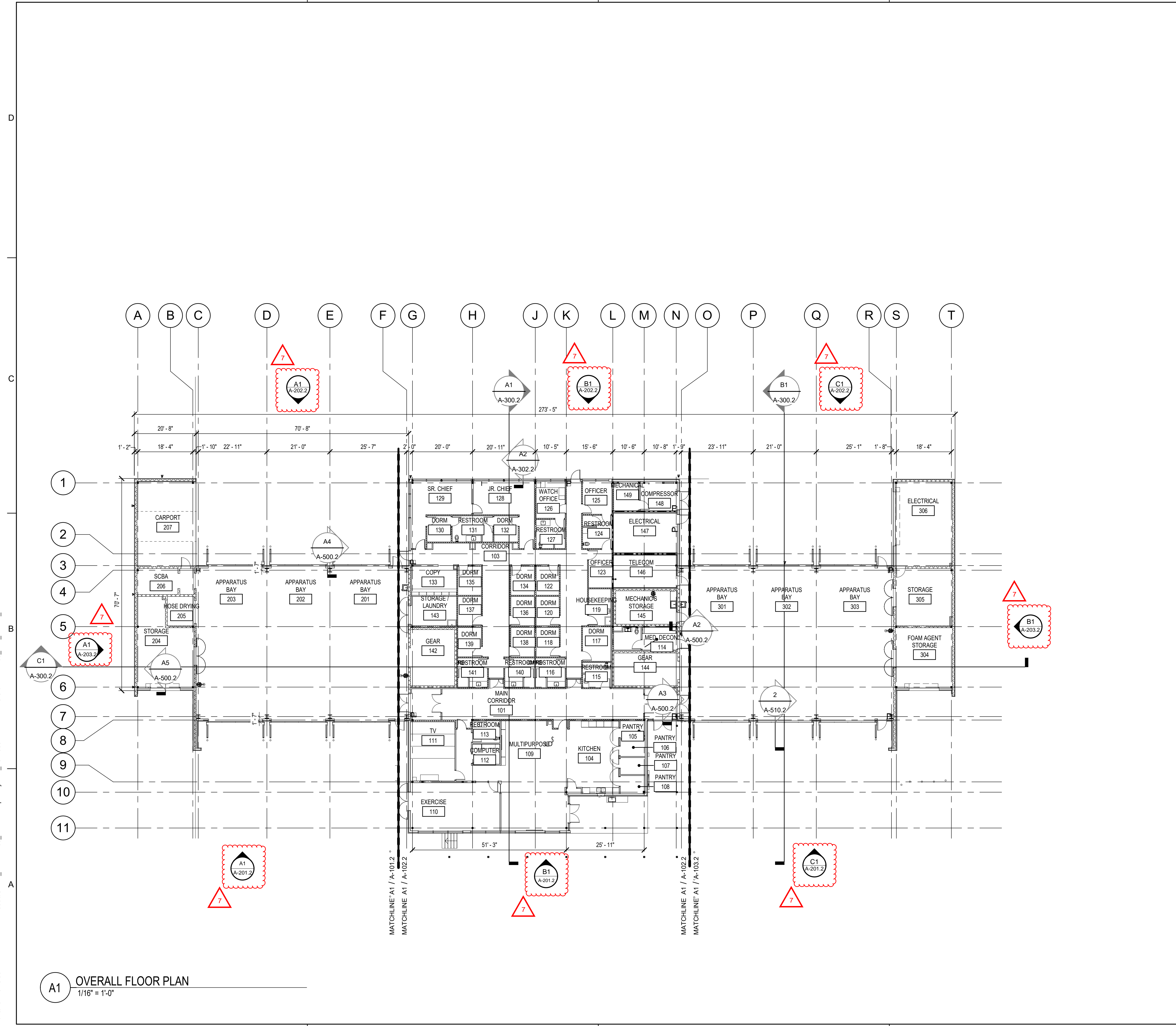
- MECHANICAL AND ELECTRICAL (300 SQ. FT. / PERSON GROSS)
- PARKING GARAGE (200 SQ. FT. / PERSON GROSS)
- BUSINESS (100 SQ. FT. / PERSON GROSS) (50 SQ. FT. / PERSON GROSS AT EXERCISE ROOMS AND LOCKER ROOMS)
- STORAGE (300 SQ. FT. / PERSON GROSS)
- DORMITORY (50 SQ. FT. / PERSON NET)
- ASSEMBLY (15 SQ. FT. / PERSON NET)

HOUSTON AIRPORT SYSTEM
PN 715E - 009
ARFF NO. 81 - PHASE 2 - 4
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Jacobs Project No.: WHXXK7109
Drawing Title:
LIFE SAFETY PLANS
Date: 04/15/22
Designed: GL
Drawn: SM
Checked: BR
Drawing No.: **G-004.2**

BIM 360/US TX_VHXX7109_Houston Airport System_LOA-009 HAS ARFF NO.81\WHXX7109_R21_A-MEP_SITE.rvt
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A1 OVERALL FLOOR PLAN
1/16" = 1'-0"

FLOOR PLAN GENERAL NOTES

- A. REFER TO G-001.2 FOR DRAWING ABBREVIATIONS, SYMBOLS AND MATERIAL.
- B. COORDINATE AND PROVIDE FIRE RATED BLOCKING FOR ALL CASEWORK / MILLWORK AND ITEMS ATTACHED OR MOUNTED TO WALLS AND CEILINGS.
- C. COORDINATE ALL MILLWORK INSTALLATIONS WITH SUBCONTRACTORS. ALL "BUILT-IN" MILLWORK SHALL BE SCRIBED TO ADJOINING WALLS, DOORS, AND CEILING WITHOUT ADDITIONAL OVERLAYS. SEAL ALL JOINTS IN ALL WALLS.
- D. PROVIDE 4' X 8' X 1/2" FIRE TREATED PLYWOOD PANEL FOR PHONE BOARD AND DATA EQUIPMENT. INSTALLATION SHALL CONFORM WITH HAS IT TECHNOLOGY SPECIFICATIONS.
- E. PROVIDE PORTABLE FIRE EXTINGUISHERS WITH A RATING OF NOT LESS THAN 2A WITHIN 75 FOOT TRAVEL DISTANCE TO ALL PORTIONS OF THE BUILDING ON THIS FLOOR. ADDITIONAL EXTINGUISHERS AS REQUIRED BY THE FIRE DEPARTMENT FIELD INSPECTOR OR BUILDING DEPARTMENT INSPECTOR.
- F. COORDINATE ALL DATA, TELECOM, AND I.T. WITH OWNER REPRESENTATIVE.
- G. ALL MANUFACTURER AND MODEL NUMBERS ARE PROVIDED AS THE BASIS OF DESIGN.
- H. REFER TO SHEET G-006.2 FOR MOUNTING HEIGHTS AND LOCATIONS OF ACCESSIBILITY FIXTURES.
- I. EXPOSED CONCRETE FLOORS. SEAL ALL CONTROL JOINT WITH ELASTOMERIC SEALANT. SAW CUT COLD JOINTS AND SEAL TO MATCH CONTROL JOINTS.
- J. ALL EXPOSED GIRDERS, BEAMS AND COLUMNS TO BE PAINTED IN THE APPARATUS BAY AREAS. SEE ROOM FINISH SCHEDULE FOR DETAILS.
- K. DOWNSPOUTS TO DRAIN TO UNDERDRAINS. REFER TO CIVIL.
- L. 6" HOT DIP GALVANIZED PIPE BOLLARDS REFER TO CIVIL.
- M. TYPICAL INTERIOR PARTITION TO BE CONSTRUCTED WITH 5/8" TYPE "X" GYPSUM BOARD ON BOTH SIDES OF 3 5/8", 20 GA. METAL STUDS AT 16" O.C. WALL EXTEND TO 6" ABOVE FINISHED CEILING.
- N. TOILET ACCESSORIES - SEE SHEET A-605.2 FOR TOILET ACCESSORIES AND PRODUCT MODEL NUMBERS.
- O. PROVIDE A VEHICLE EXHAUST SYSTEM AND CO2 SENSOR IN ALL BAYS, REFER TO MECHANICAL.
- P. REFER TO A-604.2 FOR GLAZING AND WINDOW TYPES.
- Q. WRAP BEAMS WHERE FIRE RATED ASSEMBLY EXTENDS TO ROOF DECK.
- R. SEE SPECIFICATIONS IN DIVISION 21 FOR DELEGATED DESIGN AND SUBMITTALS FOR THE FIRE SUPPRESSION SYSTEM. SUPPRESSION SYSTEM WILL BE FILED UNDER SEPARATE PERMIT.
- S. VERIFY THAT ALL BOLLARDS ARE POSITIONED TO PROVIDE NECESSARY CLEARANCE FROM MAXIMUM DOOR SWING OF APPARATUS BAY DOORS.

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REVISIONS

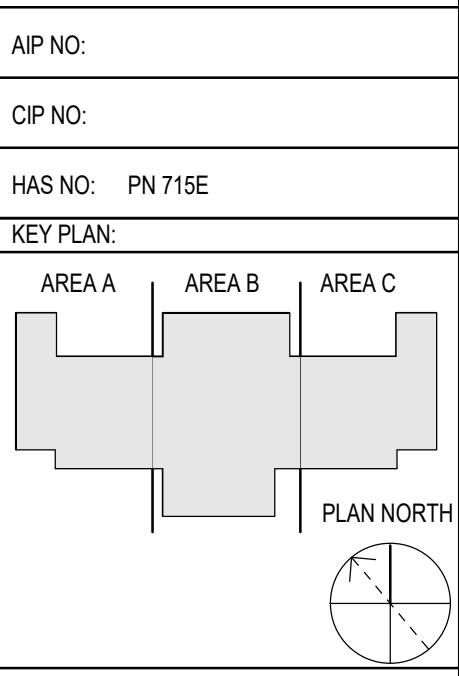
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2	07/31/2020	60% CD
3	10/01/2020	ISSUE FOR TIP/BSG REVIEW
4	01/07/2021	75% CD
5	04/15/2021	90% ISSUE FOR BID AND PERMIT
6	04/15/2022	ISSUE FOR BID
7	01/05/2023	BSG/COH REVIEW COMMENTS

OWNER:
HOUSTON AIRPORT SYSTEM
TIP-20-219-HOU
BSG-2020-223-HOU
HOUSTON AIRPORT SYSTEM

CONSULTANT:
SEAL:

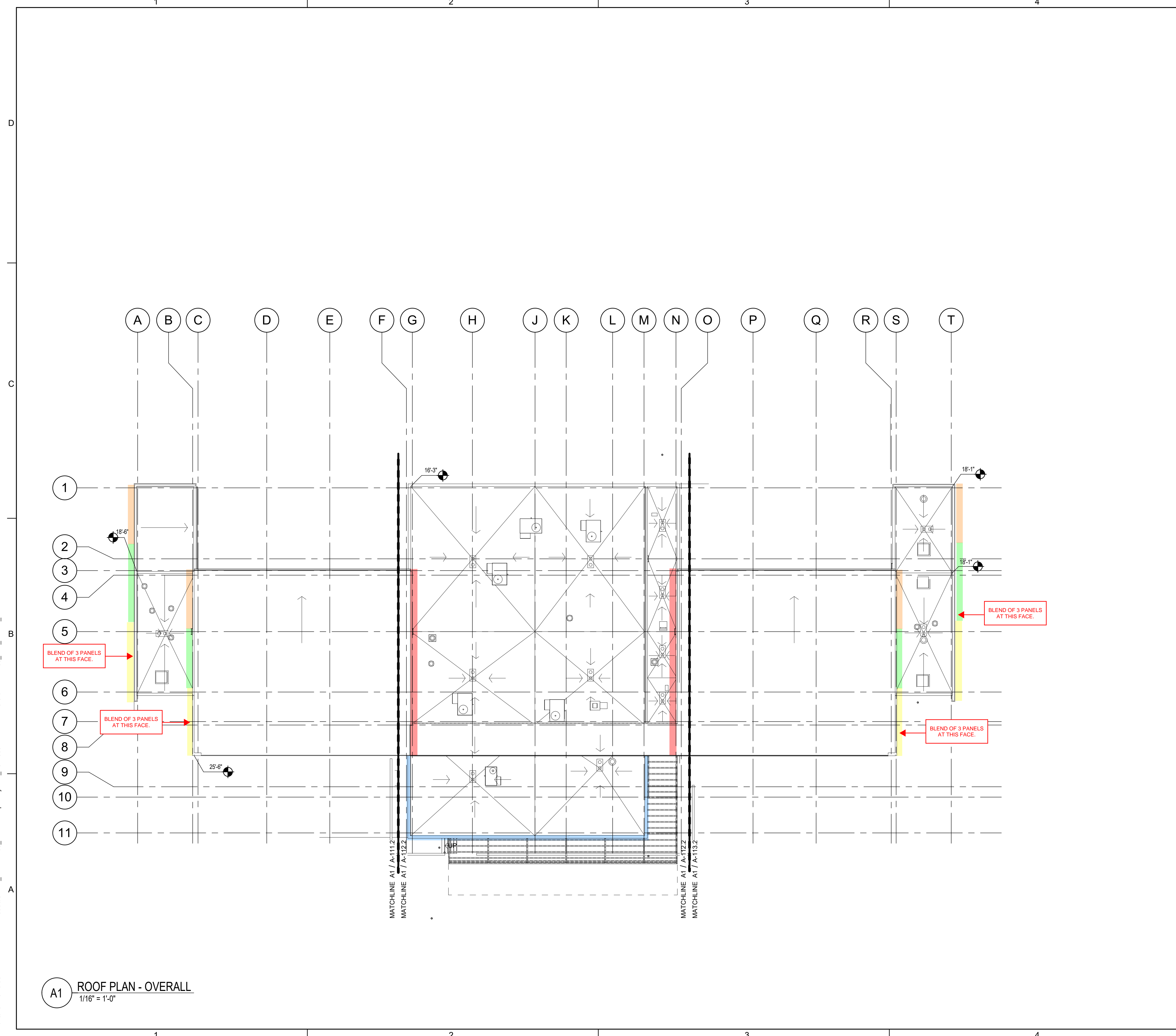
01/06/2023

HOUSTON AIRPORT SYSTEM
PN 715E - 009
ARFF NO. 81 - PHASE 2 - 4
PACKAGE 2
7990 PAUL B. KOONCE ST.
HOUSTON, TX 77061



Jacobs Project No.: WHXX7109
Drawing Title:
ARCHITECTURAL OVERALL FLOOR PLAN
Date: 04/15/22
Designed: GL Drawing No.:
Drawn: SM
Checked: BR
A-100.2

BIM_360/JUS_TX_WHXXK7109_Houston Airport System_LOA-009 HAS ARFF NO.81/WHXXK7109_R21_A-MEP_SITE.rvt 4/15/2022 6:19:06 PM



A1 ROOF PLAN - OVERALL
1/16" = 1'-0"

- ### ROOF PLAN GENERAL NOTES
- A. REFER TO G-001.2 FOR SHEET GENERAL INFORMATION, GRAPHIC SYMBOLS AND ABBREVIATIONS.
 - B. REFER TO MECHANICAL, ELECTRICAL AND PLUMBING DRAWINGS FOR ADDITIONAL ROOF PENETRATION INFORMATION.
 - C. PROVIDE 1/4" PER FOOT SLOPE MINIMUM AT ROOF FIELD. SLOPE TO DRAIN. PROVIDE 1/4" PER FOOT SLOPE MINIMUM AT ALL CRICKETS AND TAPERED INSULATION.
 - D. PROVIDE PEMB MANUFACTURER'S MINIMUM SLOPES AT ALL CRICKETS.
 - E. CONTRACTOR SHALL IMMEDIATELY NOTIFY ARCHITECT OF ANY DISCREPANCY IN CONDITIONS OR DRAWINGS AND SHALL NOT CONTINUE WITH THAT PORTION OF THE WORK UNTIL THE DISCREPANCY IS RESOLVED.
 - F. PAINT ALL EXPOSED METAL SURFACES ON ROOF, INCLUDING PRIMED SURFACES.
 - G. ALL ROOF PENETRATIONS TO RECEIVE CONTINUOUS FLASHING OR TO USE SELF-FLASHING HARDWARE.
 - H. PAINT ALL VENT STACKS TO MATCH STANDING SEAM METAL PANELS.



REVISIONS		
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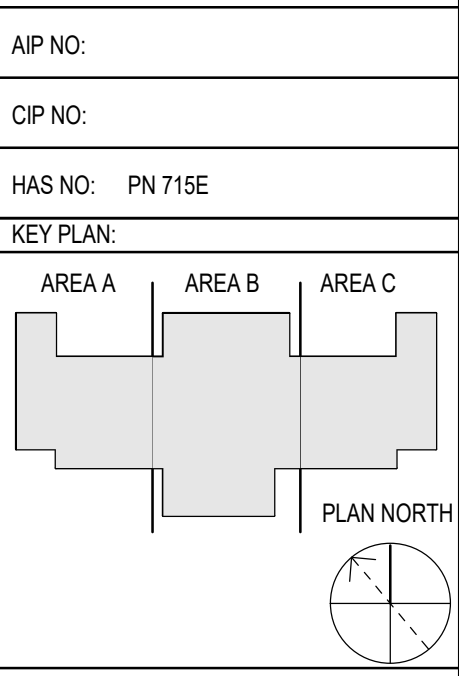
OWNER:

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 BSG-2020-223-HOU
 HOUSTON AIRPORT SYSTEM

CONSULTANT:
 SEAL:



HOUSTON AIRPORT SYSTEM
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 ARFF NO. 81 - PHASE 2 - 4
 PACKAGE 2
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Jacobs Project No.: WHXXK7109
 Drawing Title:
**ARCHITECTURAL
 OVERALL ROOF PLAN**

Date: 04/15/22
 Designed: GL Drawing No.:
 Drawn: SM
 Checked: BR

A-110.2

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A1 PARTIAL FURNITURE AND EQUIPMENT PLAN - AREA B
1/8" = 1'-0"

EQUIPMENT PLAN GENERAL NOTES

- A. REFER TO G-001.2 FOR GENERAL INFORMATION AND SYMBOLS
- B. FURNITURE AND EQUIPMENT BY OWNER (NOT IN SCOPE), LAYOUT IS PROVIDED FOR REFERENCE ONLY (UNLESS NOTED OTHERWISE).
- C. REFER TO A-606.2 FOR EQUIPMENT SCHEDULE
- D. ALL DORM ROOMS AND RESTROOM DOORS HAVE COAT HOOK, RE: SHEET A-603.2

KEYED NOTES

- 1 HIGH END RESIDENTIAL GAS RANGE WITH GRIDDLE AND DOUBLE OVEN.
- 2 FLOOR STANDING ICE MACHINE, PROVIDE POWER, WATER, AND FLOOR DRAIN.(EXISTING TO BE RELOCATED)
- 3 ADA COMPLIANT REFRIGERATOR FREEZER COMBO. OWNER FURNISHED/OWNER INSTALLED.
- 4 WALL MOUNTED EMERGENCY SHOWER WITH EYEWASH, RE: PLUMBING.
- 5 COPY MACHINE, COORDINATE REQUIREMENTS FOR POWER, DATA, AND AIR WITH FINAL SELECTED MODEL.
- 6 FRONT LOADING WASHER AND GAS DRYER.
- 7 HIGH END RESIDENTIAL BUILT-IN GRIDDLE
- 8 STEEL PAINTED WALL MOUNTED LADDER.
- 9 GEAR LOCKERS, STEEL FRAMED WITH OPEN WIRE MESH PANELS. 78 INCH X 24 INCH X 24 INCH SIZE.
- 10 VERTICAL MURPHY BED, PROVIDE ALL REQUIRED HARDWARE, AND IN-WALL BLOCKING FOR INSTALLATION.

FURNITURE TYPES LEGEND

<p>SEATING TYPES (OWNER FURNISHED/OWNER INSTALLED)</p> <ul style="list-style-type: none"> CH1 TASK CHAIR CH2 HIGH STOOL CH3 ARM CHAIR CH4 OUTDOOR ARM CHAIR CH5 SOFA CH6 BENCH CH7 WORK BENCH CH8 RECLINER <p>STORAGE TYPES (CONTRACTOR FURNISHED/CONTRACTOR INSTALLED U.N.O.)</p> <ul style="list-style-type: none"> SH1 CABINET FILE 2 DRAWER SH2 LOCKER, FULL HEIGHT SH4 2'-0" OPEN WIRE SHELVING UNIT SH5 6'-0" OPEN WIRE SHELVING UNIT SH6 OPEN WIRE LOCKER, FULL HEIGHT <p>STORAGE TYPES (OWNER FURNISHED/OWNER INSTALLED U.N.O.)</p> <ul style="list-style-type: none"> SH3 5'-0" OPEN SHELVING UNIT SH7 TOOL CABINET 3 DRAWER SH8 FIRE-RESISTANT CABINET <p>MISCELLANEOUS TYPES (CONTRACTOR FURNISHED/CONTRACTOR INSTALLED U.N.O.)</p> <ul style="list-style-type: none"> CRD1 CREDENZA BED2 MURPHY BED KCH1 STOVE WITH 2 OVENS BELOW KCH2 GRIDDLE STOVE KCH3 ICE MAKER KCH4 ICE MAKER 2 (O.F.C.I.) KCH5 DISH WASHER KCH6 REFRIGERATOR KCH7 REFRIGERATOR 2 (RELOCATED) KCH8 MICROWAVE (RELOCATED) KCH9 COFFEE MAKER (RELOCATED) KCH10 OUTDOOR GRILL (O.F.C.I.) WB1 WALL BRACKET-1 MOUNTED AT 48" A.F.F. <p>MISCELLANEOUS TYPES (OWNER FURNISHED/OWNER INSTALLED U.N.O.)</p> <ul style="list-style-type: none"> CRD2 CREDENZA 2 BED1 STANDARD BED WC1 WATER COOLER 	<p>TABLE TYPES (OWNER FURNISHED/OWNER INSTALLED U.N.O.)</p> <ul style="list-style-type: none"> TBL1 DINING TABLE TBL2 KITCHEN ISLAND (C.F.C.I.) TBL3 COFFEE TABLE TBL4 OUTDOOR TABLE TBL5 SIDE TABLE TBL6 STAINLESS STEEL PREP AND WORK TABLE (C.F.C.I.) <p>EQUIPMENT TYPES (OWNER FURNISHED/OWNER INSTALLED U.N.O.)</p> <ul style="list-style-type: none"> EQP1 WEIGHT MACHINE EQP2 WEIGHT BENCH EQP3 LIFTING BENCH EQP4 WEIGHT RACK EQP5 DUMBBELL RACK <p>WORKSTATION TYPES (CONTRACTOR FURNISHED/CONTRACTOR INSTALLED U.N.O.)</p> <ul style="list-style-type: none"> WS3 WORKSTATION 2 PB1 PIN BOARD PB2 DRY ERASE BOARD 1 - 3' WIDE PB3 DRY ERASE BOARD 2 - 6' WIDE AID1 FIRST AID KIT GAS3 GAS CYLINDER RACK WSH1 WASHER WSH2 DRYER <p>WORKSTATION TYPES (OWNER FURNISHED/OWNER INSTALLED U.N.O.)</p> <ul style="list-style-type: none"> WS1 WORKSTATION 1 WS2 DESK WC1 65" TELEVISION SCREEN TV1 65" TELEVISION SCREEN TV2 75" TELEVISION SCREEN TV3 85" TELEVISION SCREEN COM1 42" COMPUTER MONITOR COM2 24" COMPUTER MONITOR COP1 COPY MACHINE GAS1 FOAM AGENT STORAGE TANK ON PAD GAS2 HALON GAS TANK GAS4 STORAGE SHELVING
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REVISIONS

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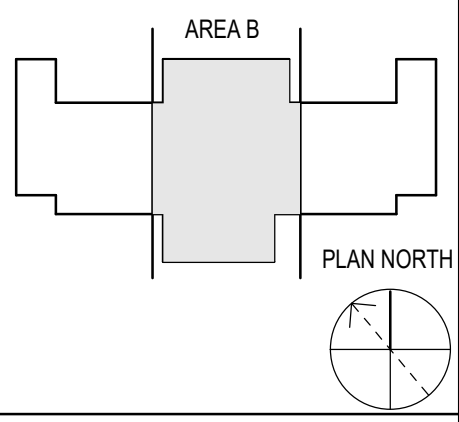
OWNER:
HOUSTON AIRPORT SYSTEM
TIP-20-219-HOU
BSG-2020-223-HOU
HOUSTON AIRPORT SYSTEM

CONSULTANT:



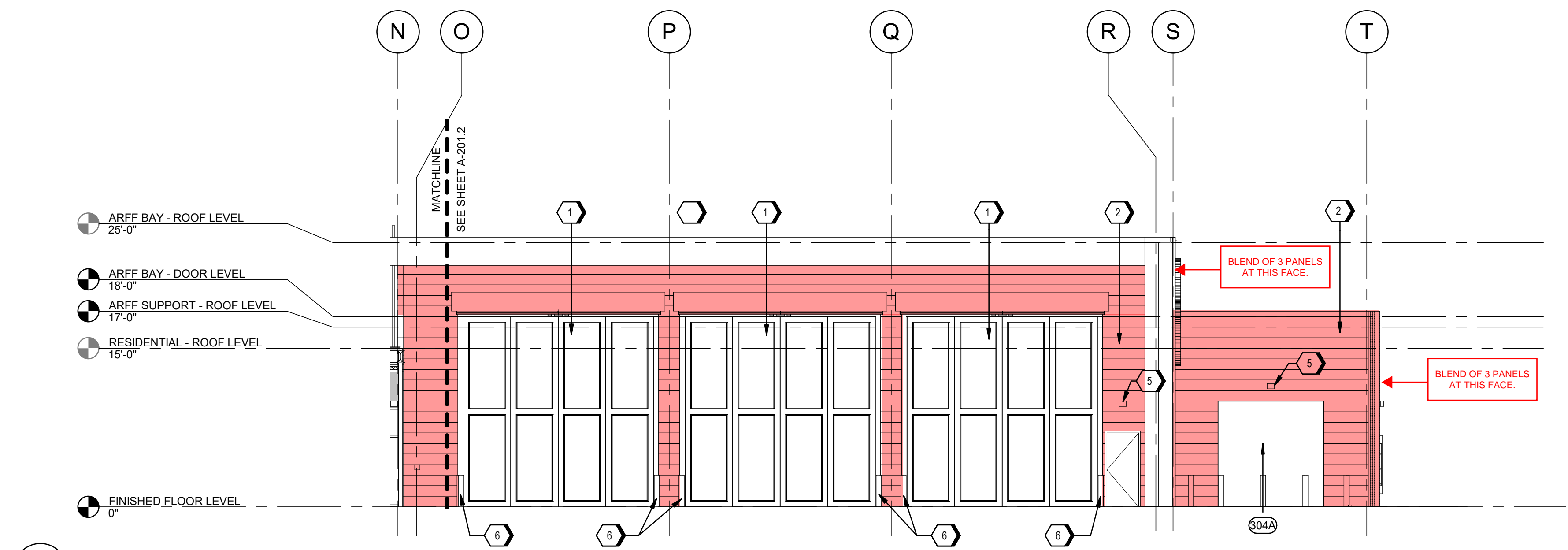
HOUSTON AIRPORT SYSTEM
PN 715E - 009
ARFF NO. 81 - PHASE 2 - 4
PACKAGE 2
7990 PAUL B. KOONCE ST.
HOUSTON, TX 77061

AIP NO:
CIP NO:
HAS NO: PN 715E
KEY PLAN:

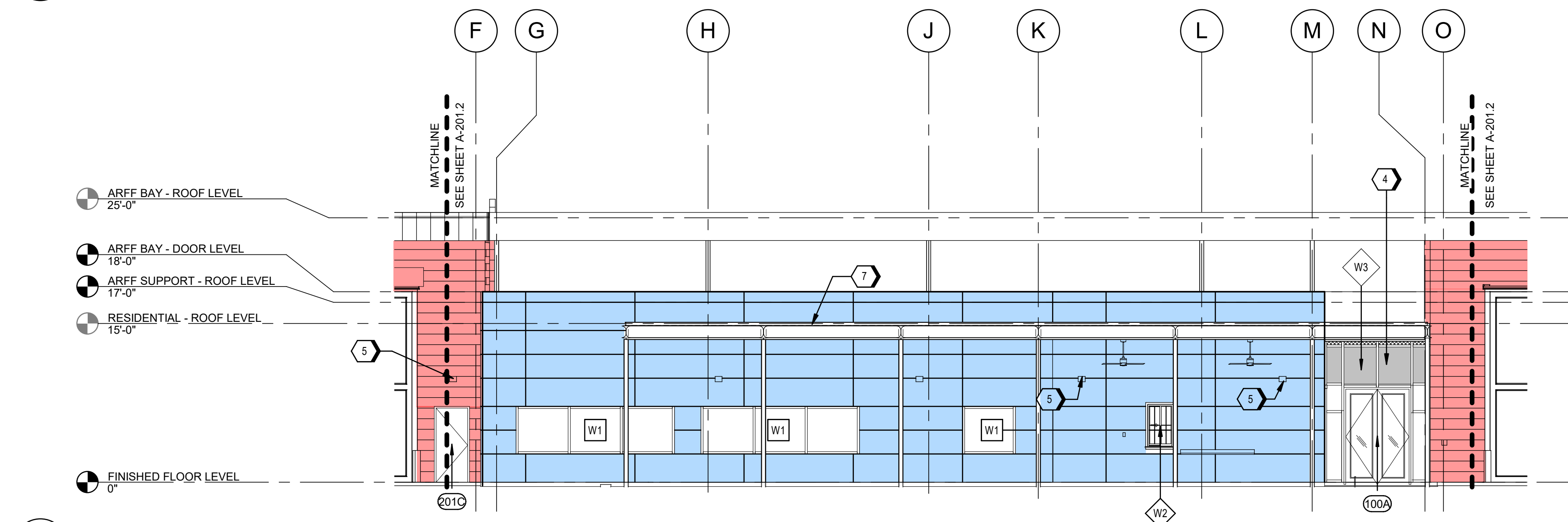


Jacobs Project No.: WHXX7109
Drawing Title:
PARTIAL FURNITURE AND EQUIPMENT PLAN - AREA B
Date: 04/15/22
Designed: GL
Drawn: SM
Checked: BR
Drawing No.: **A-142.2**

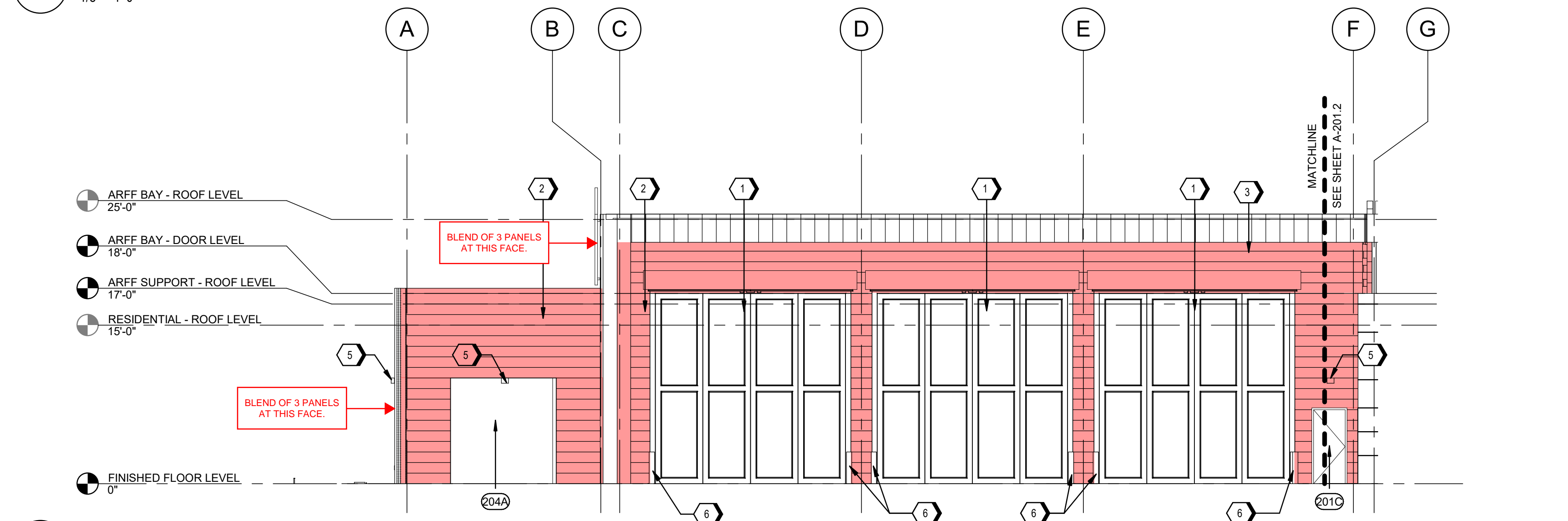
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C1 ELEVATION - SOUTH - AREA C
1/8" = 1'-0"



B1 ELEVATION - SOUTH - AREA B
1/8" = 1'-0"



A1 ELEVATION - SOUTH - AREA A
1/8" = 1'-0"

EXTERIOR ELEVATION GENERAL NOTES

- A. REFER TO G-001.2 FOR GENERAL INFORMATION AND SYMBOLS
- B. REFER TO SHEET A-603.2 FOR DOOR TYPES AND SCHEDULE
- C. REFER TO SHEET A-101.2, A-102.2 AND A-103.2 FOR DOOR AND WINDOW TYPE LOCATIONS.
- D. REFER TO SHEET A-604.2 FOR WINDOW AND GLAZING TYPES.
- E. PROVIDE SILICON CAULKING AND SEALANT WHERE REQUIRED.

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6	04/15/2022	ISSUE FOR BID

OWNER:
HOUSTON AIRPORT SYSTEM
TIP-20-219-HOU
BSG-2020-223-HOU
HOUSTON AIRPORT SYSTEM

CONSULTANT:

KEYED NOTES

- 1 VERTICAL FOLDING HORIZONTAL BIFOLD BAY DOORS.
- 2 METAL PANEL RAINSCREEN SYSTEM.
- 3 ANODIZED FINISHED ALUMINUM STOREFRONT AND NON-INSULATED GLAZING SYSTEM.
- 4 ANODIZED FINISHED ALUMINUM CURTAINWALL AND INSULATED GLAZING SYSTEM.
- 5 WALL PAK AND WALL MOUNTED LIGHTING, RE: ELECTRICAL
- 6 6" HDG PIPE BOLLARD, RE: CIVIL FOR TYPICAL DETAIL.
- 7 STEEL CANOPY STRUCTURE, RE: STRUCTURAL

SEAL:

04/15/2022

LEGEND

	BOX RIB PANEL 1		PROFILE
	BOX RIB PANEL 2		PROFILE
	BOX RIB PANEL 3		PROFILE
	BOX RIB PANEL 4		PROFILE

ELEVATIONS ARE A BLEND OF THESE 3 PANELS.

HOUSTON AIRPORT SYSTEM
PN 715E - 009
ARFF NO. 81 - PHASE 2 - 4
PACKAGE 2
7990 PAUL B. KOONCE ST.
HOUSTON, TX 77061

AIP NO:
CIP NO:
HAS NO: PN 715E

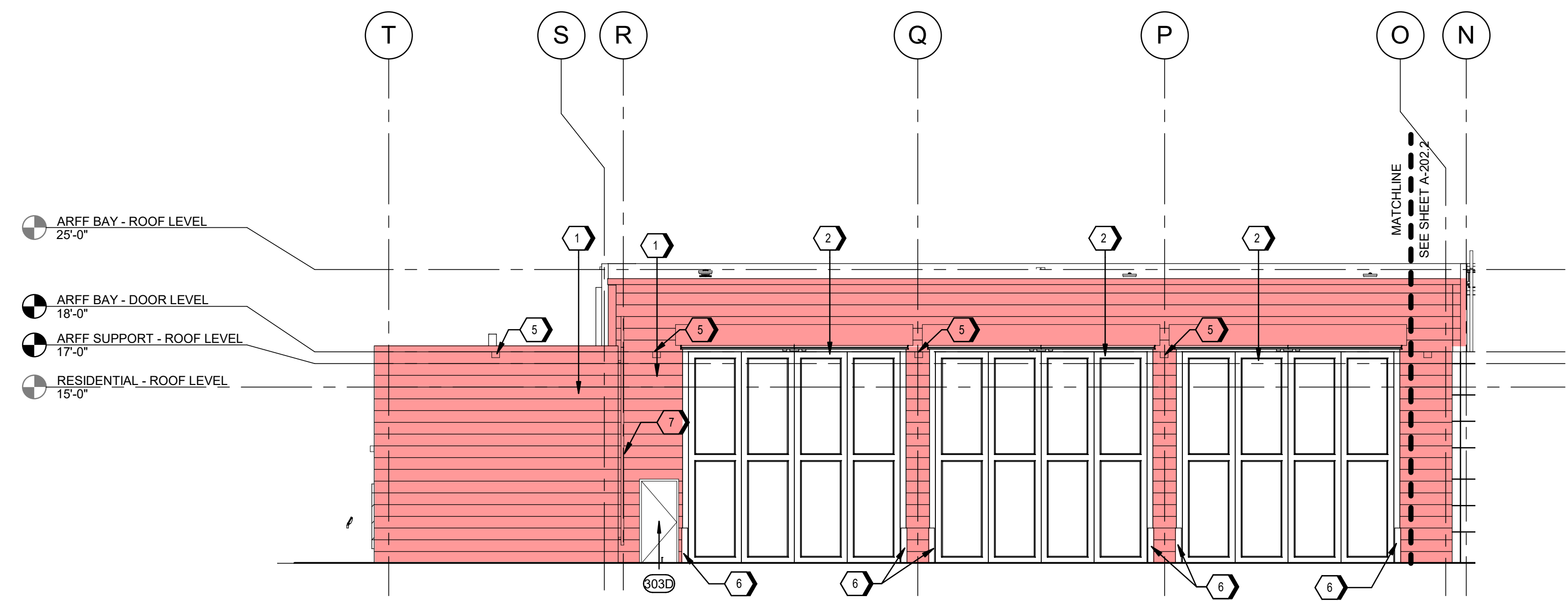
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Drawing Title:

EXTERIOR ELEVATIONS

Date: 04/15/22
Designed: GL
Drawn: AG
Checked: BR
Drawing No.: **A-201.2**

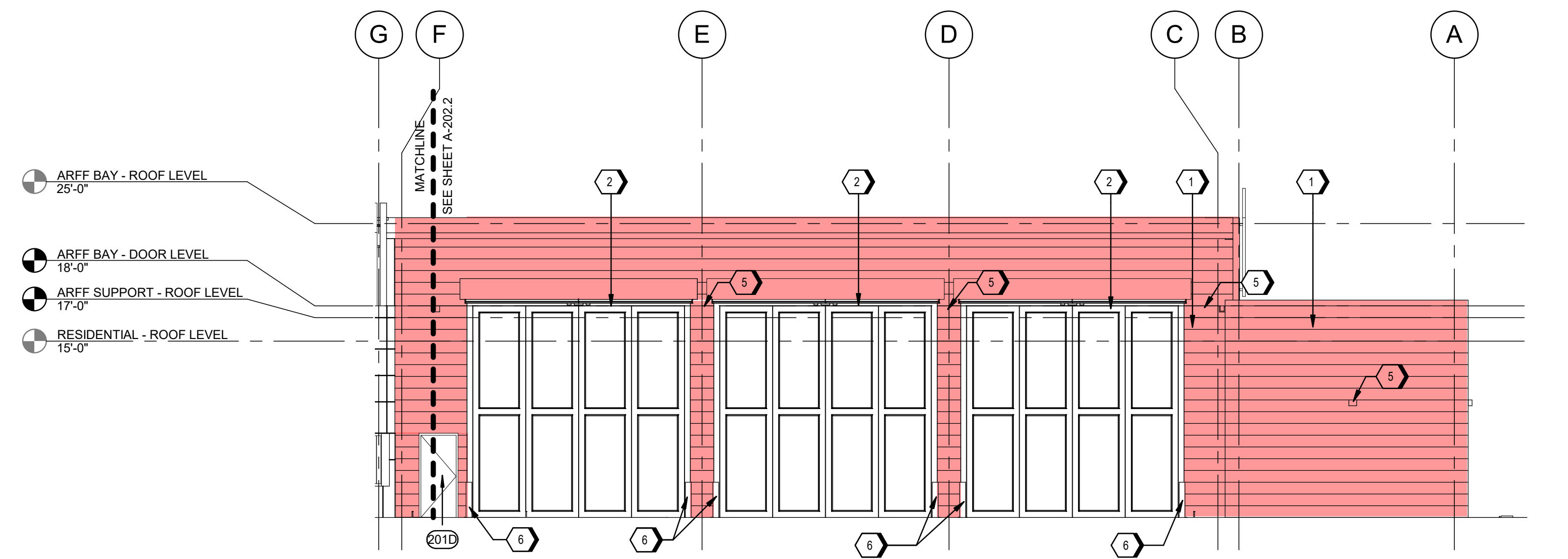
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C1 ELEVATION - NORTH - AREA C
1/8" = 1'-0"



B1 ELEVATION - NORTH - AREA B
1/8" = 1'-0"

A1 ELEVATION - NORTH - AREA A
1/8" = 1'-0"



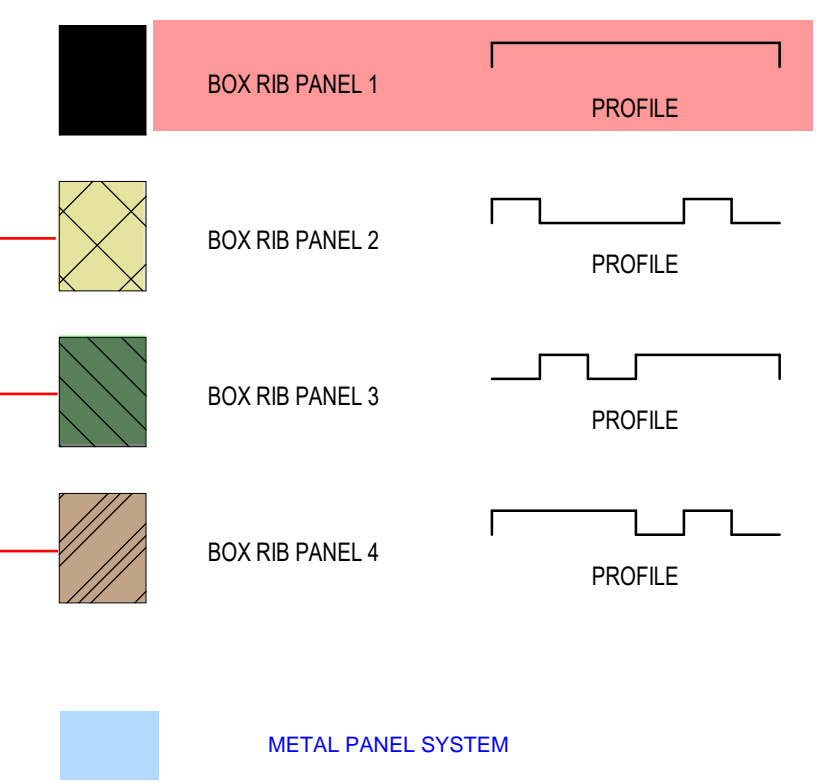
EXTERIOR ELEVATION GENERAL NOTES

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- B. REFER TO SHEET A-603.2 FOR DOOR TYPES AND SCHEDULE
- C. REFER TO SHEET A-101.2, A-102.2 AND A-103.2 FOR DOOR AND WINDOW TYPE LOCATIONS.
- D. REFER TO SHEET A-604.2 FOR WINDOW AND GLAZING TYPES.
- E. PROVIDE SILICON CAULKING AND SEALANT WHERE REQUIRED.

KEYED NOTES

- 1 METAL PANEL RAINSCREEN SYSTEM
- 2 VERTICAL FOLDING HORIZONTAL BIFOLD BAY DOORS
- 3 ANODIZED FINISHED ALUMINUM STOREFRONT AND INSULATED GLAZING SYSTEM
- 4 PAINT EXPOSED STEEL COLUMNS
- 5 WALL PAK AND WALL MOUNTED LIGHTING, RE: ELECTRICAL
- 6 6" HDG PIPE BOLLARD, RE: CIVIL FOR TYPICAL DETAIL
- 7 STEEL PAINTED WALL MOUNTED LADDER

LEGEND



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OWNER:
HOUSTON AIRPORT SYSTEM
TIP-20-219-HOU
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HOUSTON AIRPORT SYSTEM

CONSULTANT:



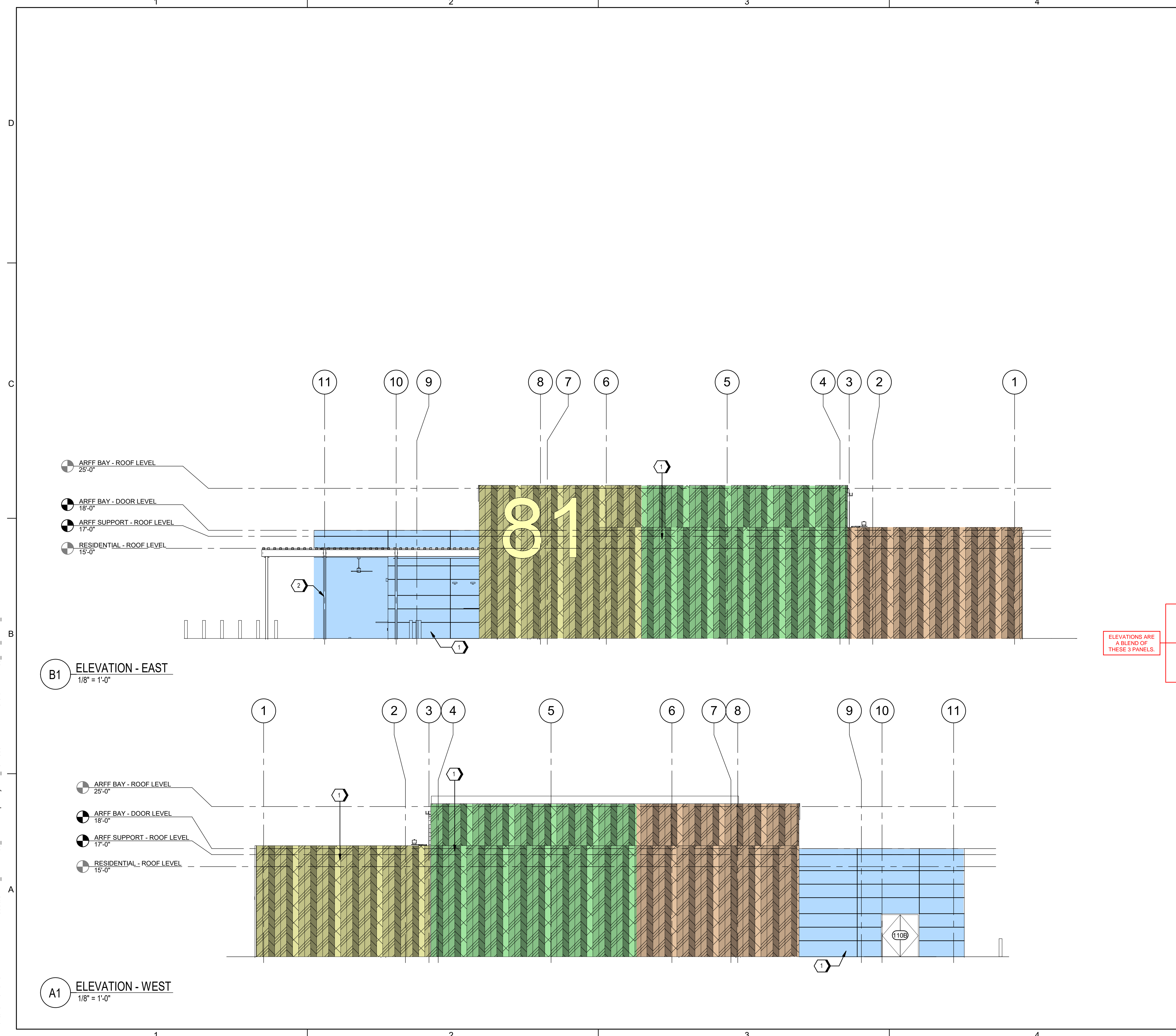
HOUSTON AIRPORT SYSTEM
PN 715E - 009
ARFF NO. 81 - PHASE 2 - 4
PACKAGE 2
7990 PAUL B. KOONCE ST.
HOUSTON, TX 77061

AIP NO:
CIP NO:
HAS NO: PN 715E

Jacobs Project No.: WHXK7109
Drawing Title:

EXTERIOR ELEVATIONS
Date: 04/15/22
Designed: GL Drawing No.:
Drawn: SM
Checked: BR **A-202.2**

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EXTERIOR ELEVATION GENERAL NOTES

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- B. REFER TO SHEET A-603.2 FOR DOOR TYPES AND SCHEDULE
- C. REFER TO SHEET A-101.2, A-102.2 AND A-103.2 FOR DOOR AND WINDOW TYPE LOCATIONS.
- D. REFER TO SHEET A-604.2 FOR WINDOW AND GLAZING TYPES.
- E. PROVIDE SILICON CAULKING AND SEALANT WHERE REQUIRED.



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OWNER:
HOUSTON AIRPORT SYSTEM
TIP-20-219-HOU
BSG-2020-223-HOU
HOUSTON AIRPORT SYSTEM

KEYED NOTES

- 1 METAL PANEL RAINSCREEN SYSTEM.
- 2 PAINT EXPOSED STEEL COLUMNS



LEGEND

	BOX RIB PANEL 1	
	BOX RIB PANEL 2	
	BOX RIB PANEL 3	
	BOX RIB PANEL 4	
	METAL PANEL SYSTEM	

HOUSTON AIRPORT SYSTEM
PN 715E - 009
ARFF NO. 81 - PHASE 2 - 4
PACKAGE 2
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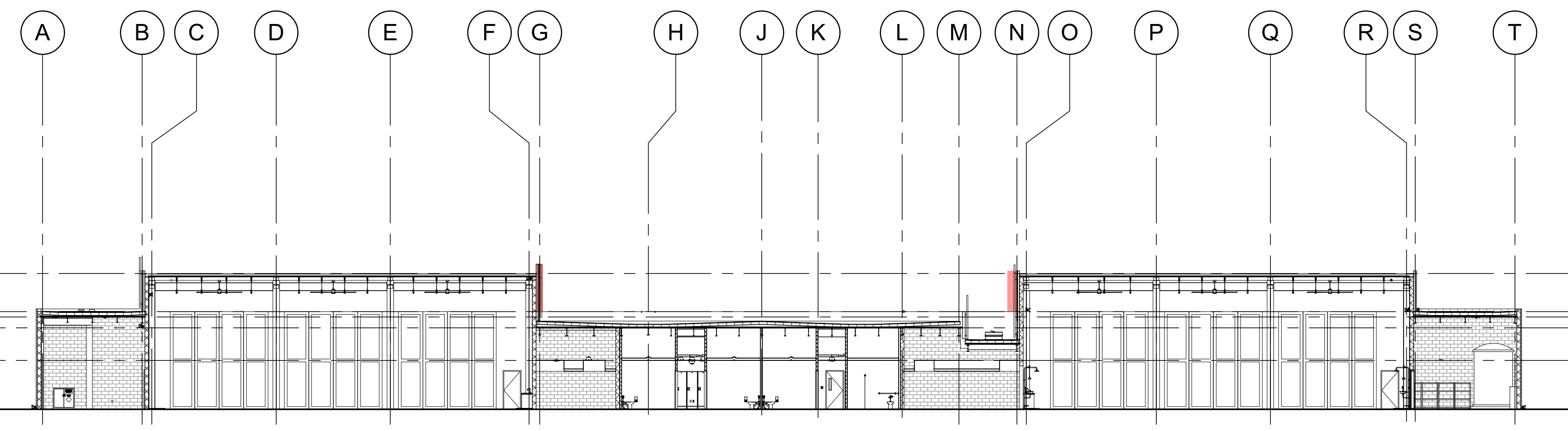
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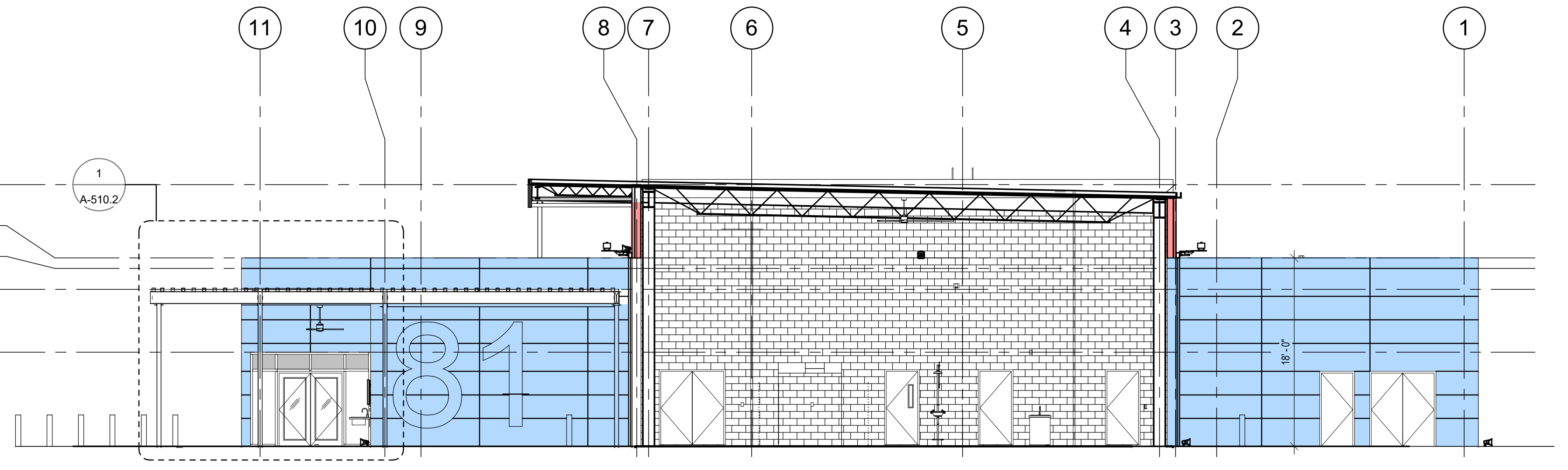
EXTERIOR ELEVATIONS

Date: 04/15/22
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Drawn: SM
Checked: BR **A-203.2**

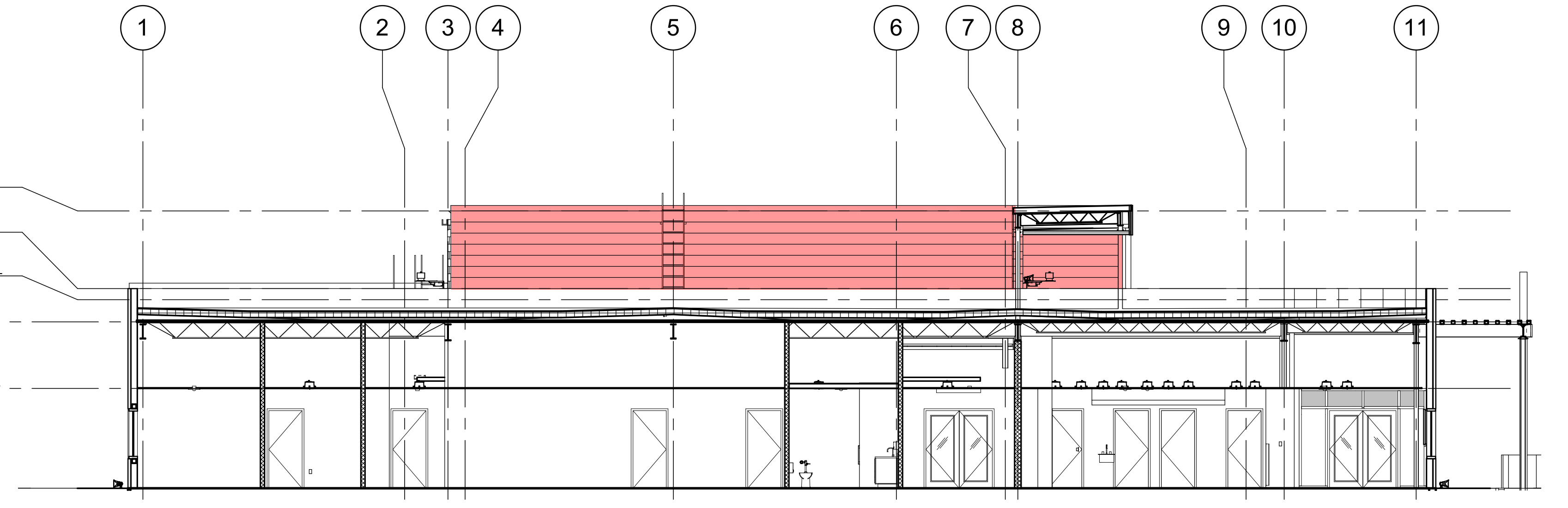
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C1 SECTION - EAST TO WEST
1/16" = 1'-0"



B1 BUILDING SECTION - NORTH TO SOUTH
1/8" = 1'-0"



A1 BUILDING SECTION - NORTH TO SOUTH
1/8" = 1'-0"

BUILDING SECTION GENERAL NOTES

- A. REFER TO G-001.2 FOR GENERAL INFORMATION, SYMBOLS AND DESIGN PHASE.
- B. REFER TO A-101.2, A-102.2 AND A-103.2 FOR COLUMN GRID, WINDOW TYPES AND DOOR LOCATIONS
- C. REFER TO A-603.2 FOR DOOR SCHEDULES AND TYPES
- D. REFER TO A-604.2 FOR WINDOW AND GLAZING TYPES AND SCHEDULES



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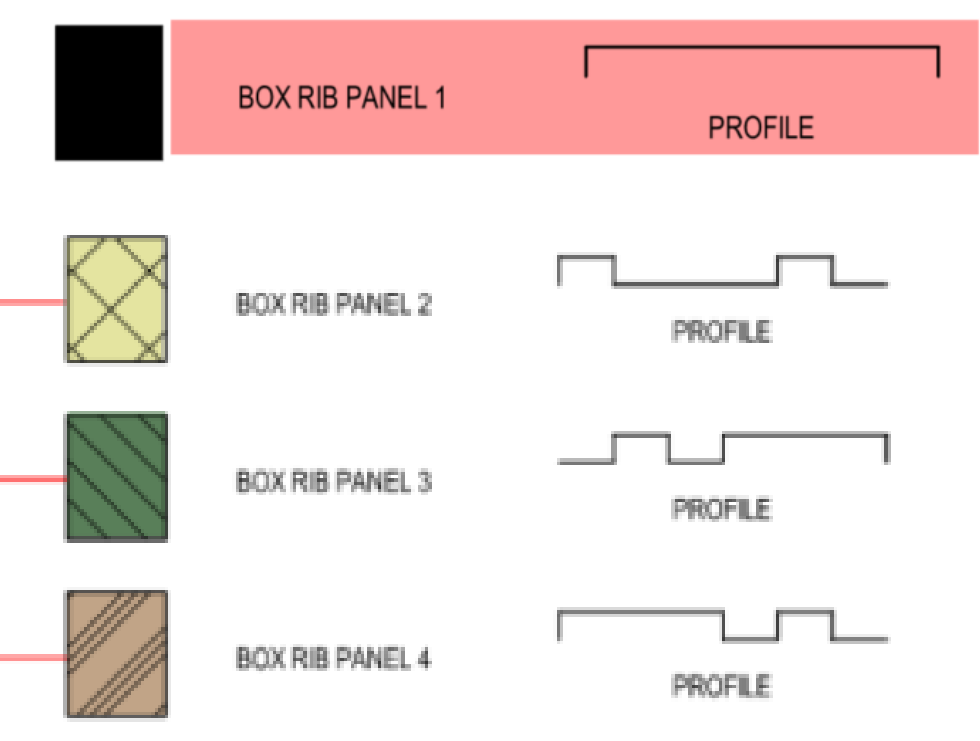
OWNER:
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HOUSTON AIRPORT SYSTEM

CONSULTANT:



KEYED NOTES

LEGEND



ELEVATIONS ARE A BLEND OF THESE 3 PANELS.

HOUSTON AIRPORT SYSTEM
PN 715E - 009
ARFF NO. 81 - PHASE 2 - 4
PACKAGE 2
7990 PAUL B. KOONCE ST.
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AIP NO:
CIP NO:
HAS NO: PN 715E

Jacobs Project No.: WHXX7109
Drawing Title:

BUILDING SECTIONS

Date: 04/15/22
Designed: GL Drawing No.:
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Checked: BR **A-300.2**

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B1 VIEW FROM SOUTH - AREA B,C




A1 A P2 VIEW FROM SOUTH

REVISIONS		
Mark	Date	Description
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 HOUSTON AIRPORT SYSTEM

CONSULTANT:

 04/15/2022

SEAL:

 04/15/2022

HOUSTON AIRPORT SYSTEM
 PN 715E - 009
 ARFF NO. 81 - PHASE 2 - 4
 PACKAGE 2
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AIP NO:
 CIP NO:
 HAS NO: PN 715E

Jacobs Project No.: WHXXK7109
 Drawing Title:
 3D VIEWS


Date: 04/15/22
 Designed: GL Drawing No.:
 Drawn: SM
 Checked: BR **A-701.2**


BIM_360/IUS_TX_WHXX7109_Houston Airport System_LOA-009 HAS ARFF NO.81/WHXX7109_R21_A-MEP_SITE.rvt
4/15/2022 6:23:57 PM

REVISIONS		
Mark	Date	Description
1	1/17/2020	ISSUED FOR PRICING
2	07/31/2020	60% CD
3	10/01/2020	ISSUE FOR TIP/BSG REVIEW
4	01/07/2021	75% CD
5	04/15/2021	90% ISSUE FOR BID AND PERMIT
6	04/15/2022	ISSUE FOR BID

OWNER:

 HOUSTON AIRPORT SYSTEM
 TIP-20-219-HOU
 BSG-2020-223-HOU
 HOUSTON AIRPORT SYSTEM

CONSULTANT:

 04/15/2022

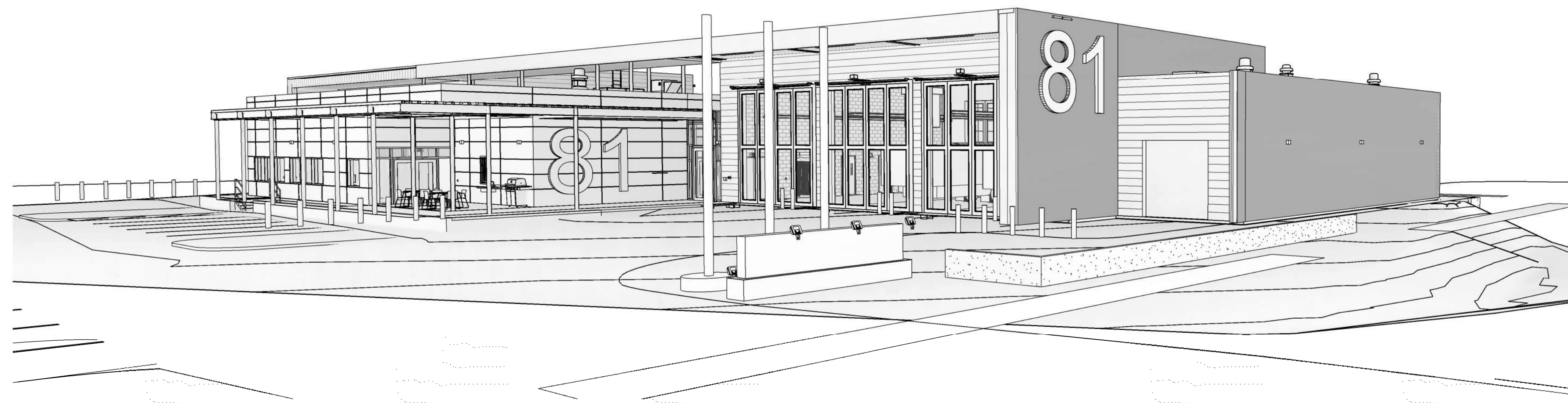
SEAL:

 04/15/2022

HOUSTON AIRPORT SYSTEM
 PN 715E - 009
 ARFF NO. 81 - PHASE 2 - 4
 PACKAGE 2
 7990 PAUL B. KOONCE ST.
 HOUSTON, TX 77061

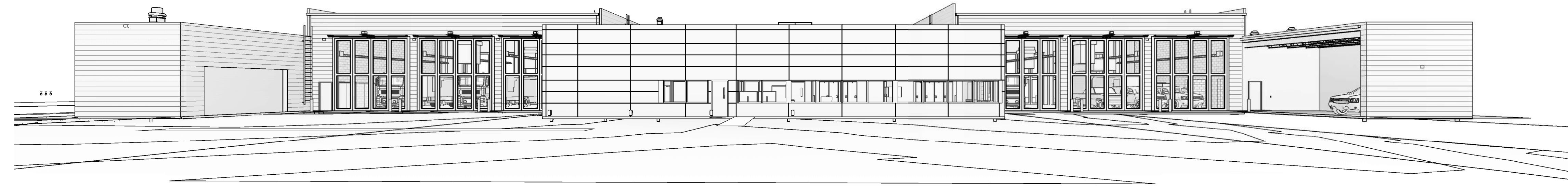
AIP NO:
 CIP NO:
 HAS NO: PN 715E

Jacobs Project No.: WHXX7109
 Drawing Title:
 3D VIEWS

Date: 04/15/22
 Designed: GL Drawing No.:
 Drawn: SM
 Checked: BR **A-702.2**



B1 A P2 VIEW FROM APPROACH STREET SOUTH
 NOT TO SCALE



A1 A P2 VIEW FROM AIRFIELD NORTH
 NOT TO SCALE