20 October 2023



ADDENDUM 01

PROJECT: William Fox Elementary School Reconstruction

Richmond Public Schools

IFB: 23-7053-10 QE: 42240940

The following items represent changes, modifications and/or clarifications to the Contract Documents for this project. This Addendum shall become a part of the Contract Documents and all Bidders shall acknowledge its inclusion in their bid.

Changes to Drawings:

- 1. REPLACE the following Sheets with the Revised Sheets contained herein:
 - Sheet AD101 Demolition Plan Level 1
 - Sheet AD102 Demolition Plan Level 2
 - Sheet AD103 Demolition Plan Level 3
 - Sheet A131 Finish Plan Level 1
 - Sheet A132 Finish Plan Level 2
 - Sheet A133 Finish Plan Level 3 & Mezzanine
 - Sheet A201 Building Elevations
 - Sheet M003 Mechanical Schedules
 - Sheet M103 Level 3 Floor Plan Ductwork
 - Sheet M203 Level 3 Floor Plan Piping
 - Sheet M304 Mechanical Sections
 - Sheet E101 Floor Plan Level 1 Lighting
 - Sheet E103 Floor Plan Level 3 Lighting
 - Sheet E201 Floor Plan Level 1 Power
 - Sheet E203 Floor Plan Level 3 Power
 - Sheet E301 Floor Plan Level 1 HVAC Power
 - Sheet E303 Floor Plan Level 3 HVAC Power
 - Sheet E304 Attic Plan Level 4 HVAC Power
 - Sheet E503 Panelboard Schedules

Changes to Specifications:

- 1. Table of Contents: <u>ADD</u> the following Specification Sections
 - 323119 Decorative Metal Fencing
- 2. Section 230500 Heating, Ventilating and Air Conditioning Equipment:

DELETE and **REPLACE** with revised Section 230500 included in this Addendum

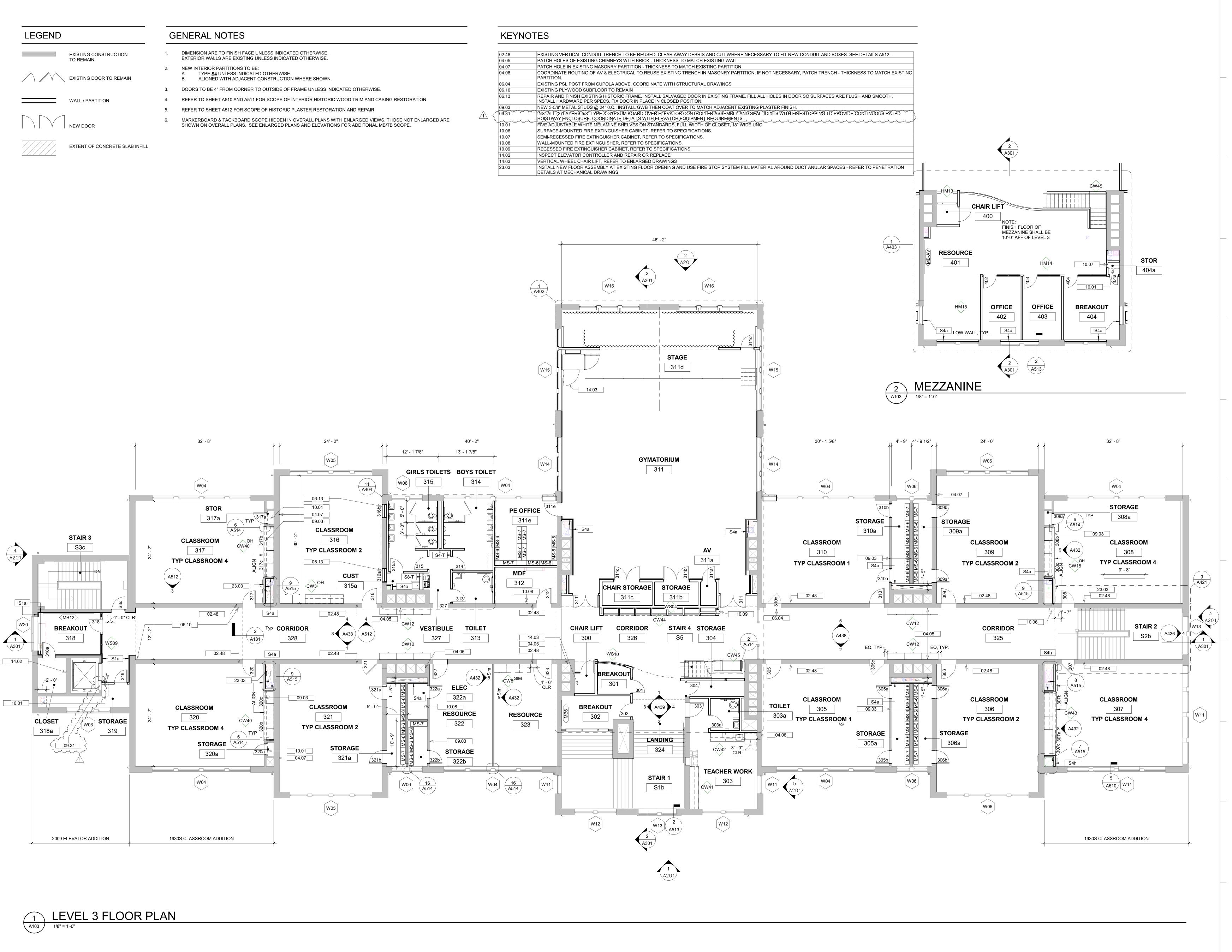
20 October 2023

3. A201 General Conditions of the Contract for Construction, Paragraph 4.3.7.2:

<u>DELETE</u> the NOAA Weather Data Table and **<u>REPLACE</u>** with the following:

MONTH	MP/FT	MONTH	MP/FT
January	07/01	July	08/00
February	06/01	August	05/00
March	07/00	September	06/00
April	06/00	October	05/00
May	07/00	November	07/00
June	05/00	December	07/01

END OF ADDENDUM 001



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WILLIAM FOX ELEMENTARY SCHOOL RECONSTRUCTION

RICHMOND PUBLIC SCHOOLS

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STATE PROJECT No: 123-20-00-101

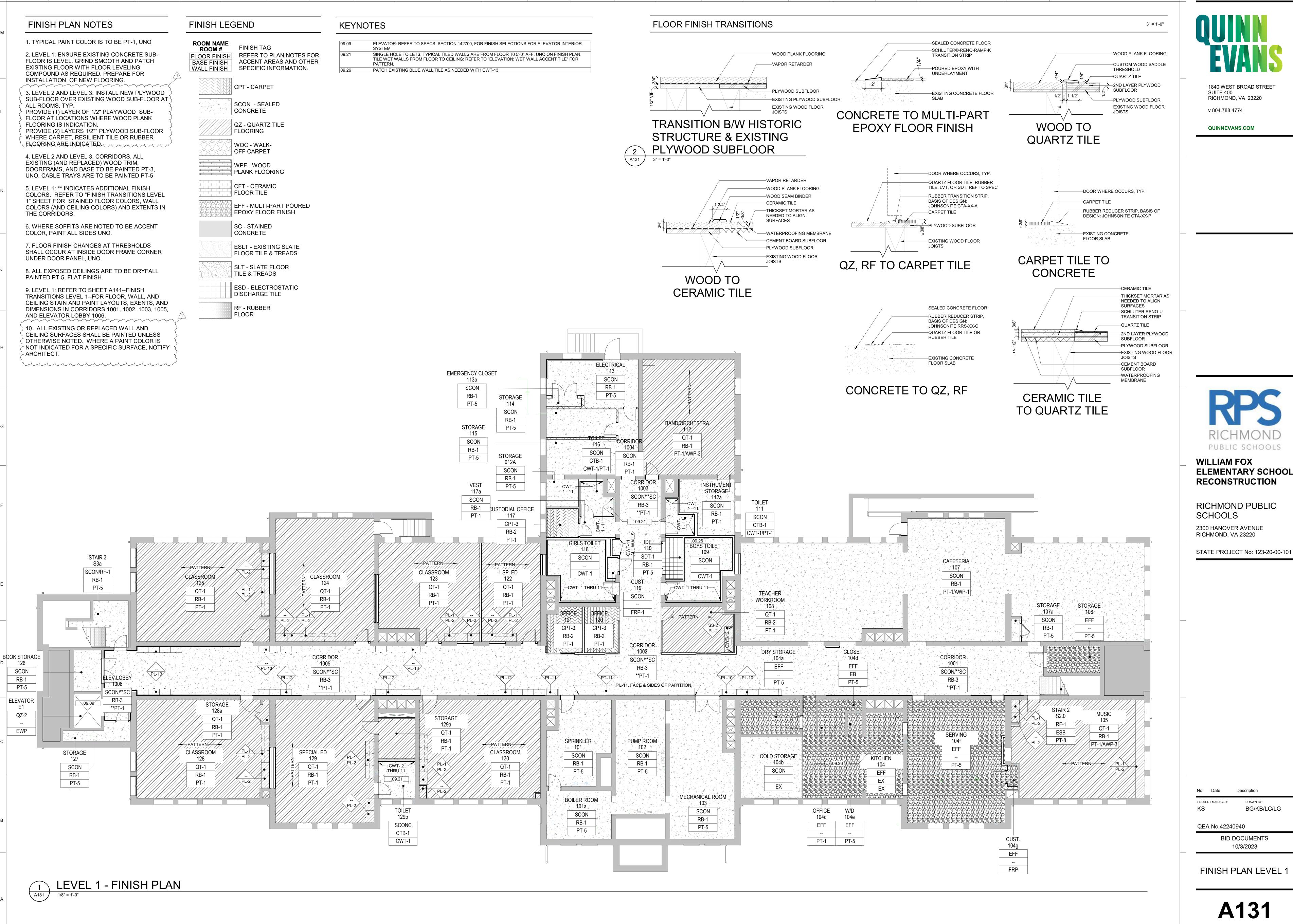
1 10/18/2023 ADDENDUM 001

QEA No.42240940

BID DOCUMENTS 10/3/2023

BG/KB/LC/LG

FLOOR PLAN LEVEL 3 & MEZZANINE



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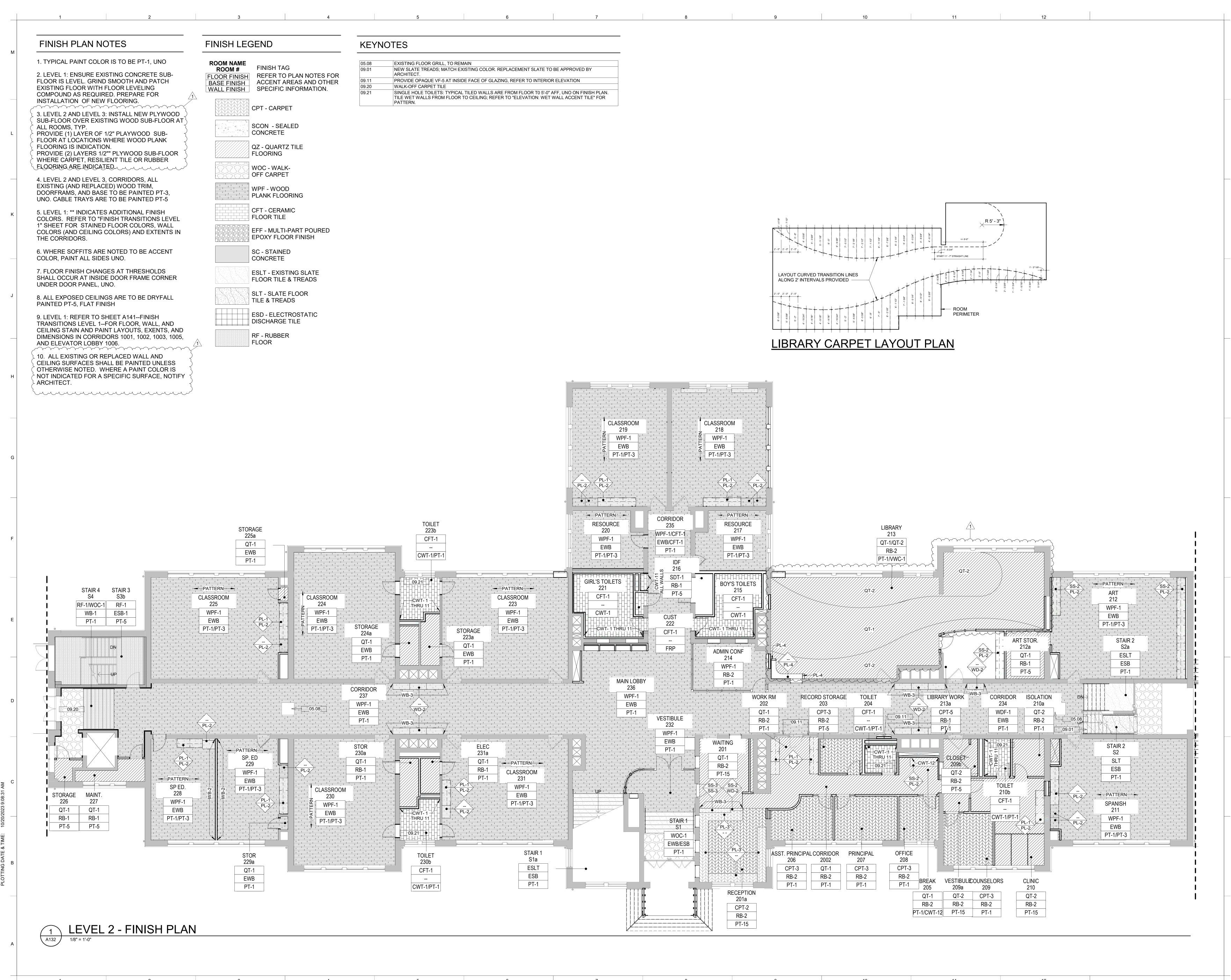
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FINISH PLAN LEVEL 1



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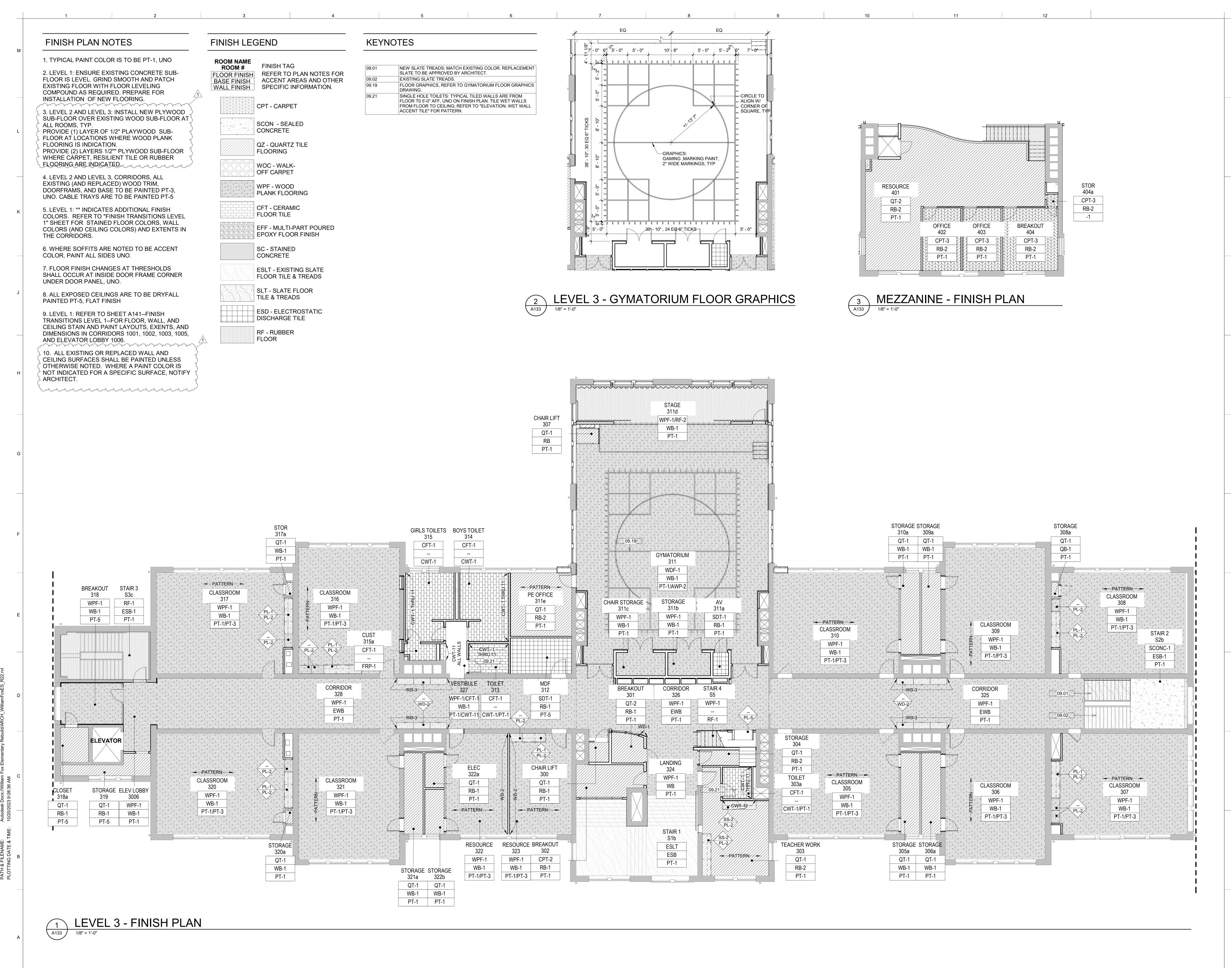
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FINISH PLAN LEVEL 2



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No. Date Description

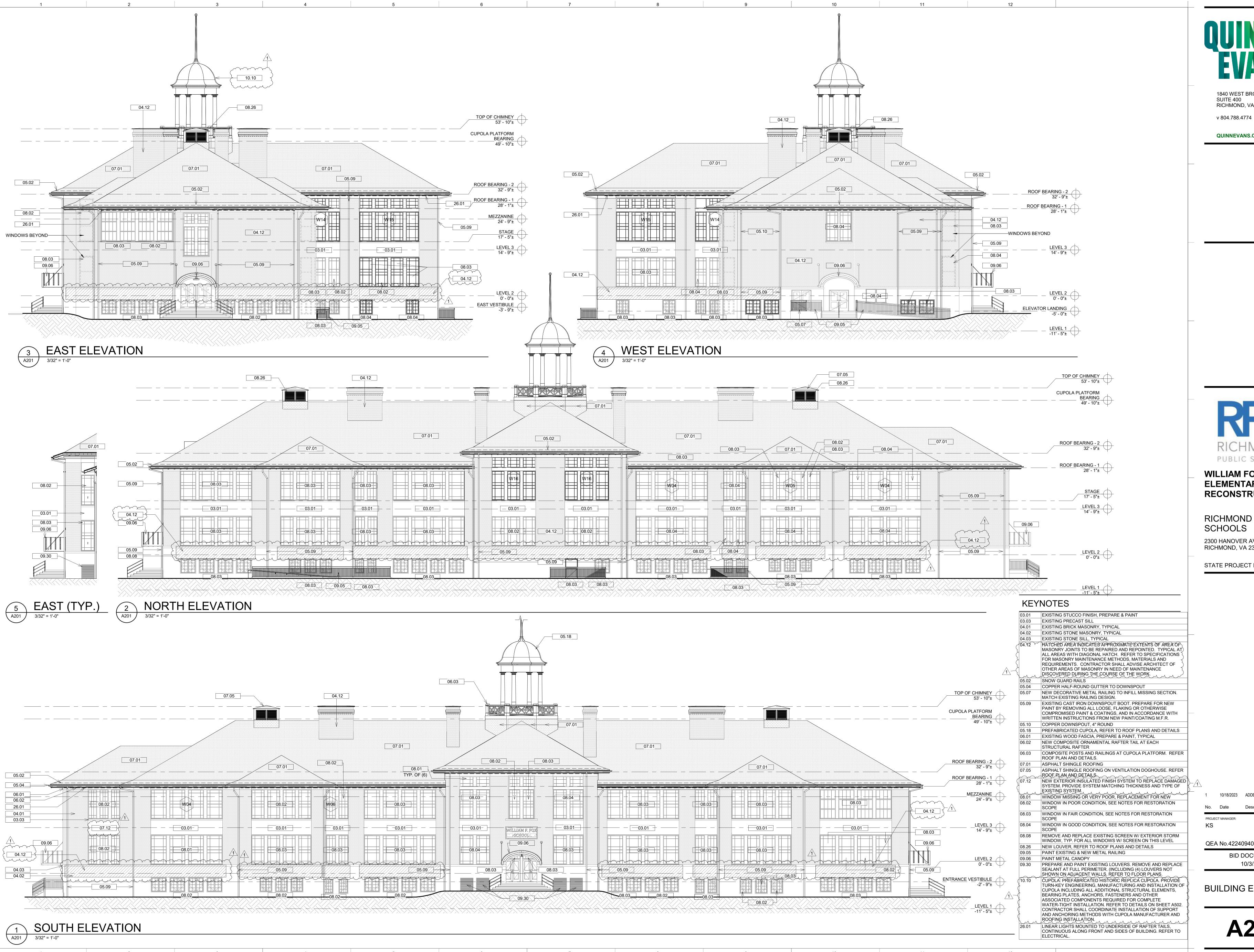
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FINISH PLAN LEVEL 3 & MEZZANINE



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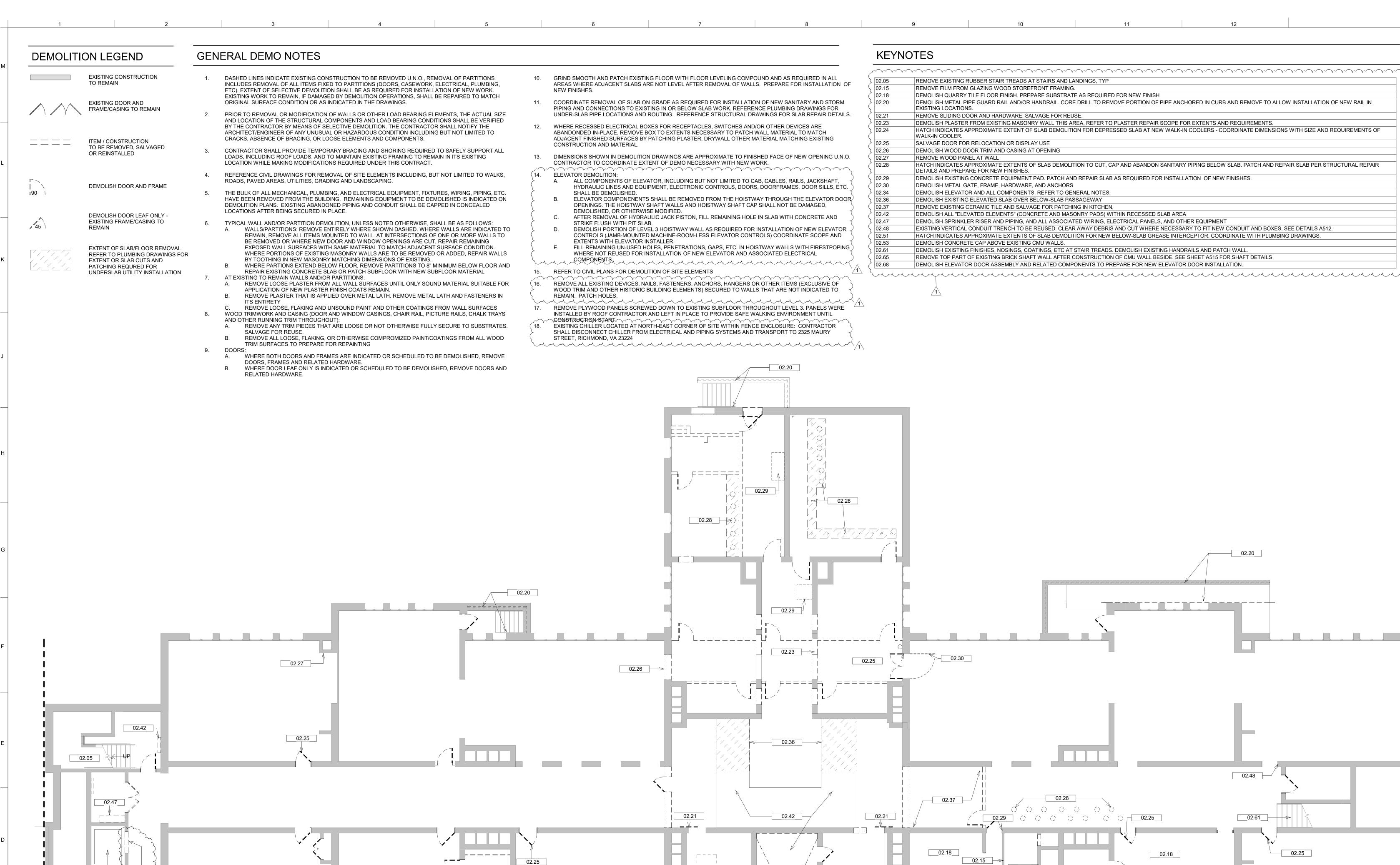
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BUILDING ELEVATIONS



02.29

02.36

02.53



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02.25

02.26

02.25

02.18

02.25 02.51

02.15

02.18

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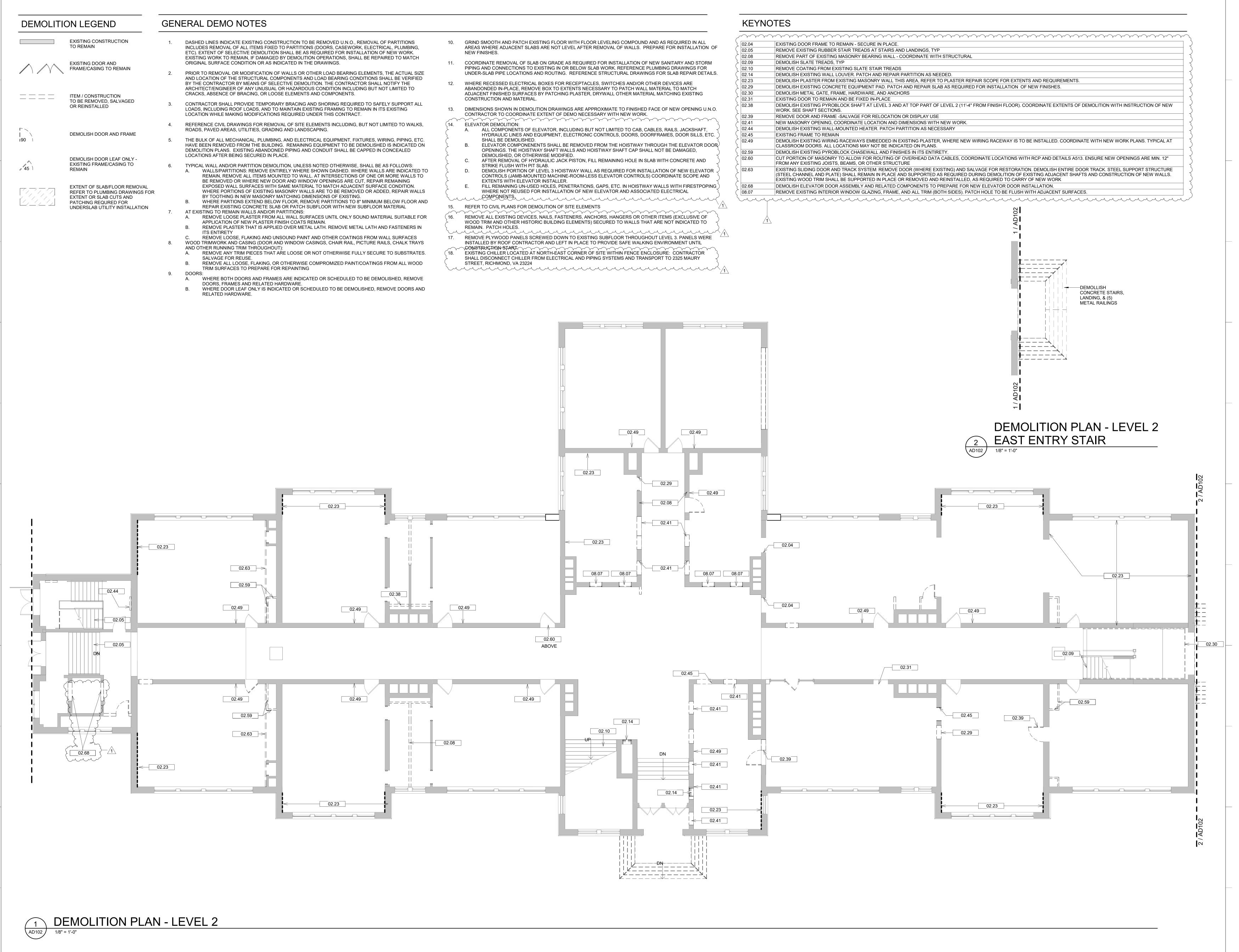
DEMOLITION PLAN -LEVEL 1

AD101

02.29

DEMOLISH METAL PIPE GUARD RAIL AND/OR HANDRAIL. CORE DRILL TO REMOVE PORTION OF PIPE ANCHORED IN CURB AND REMOVE TO ALLOW INSTALLATION OF NEW RAIL IN DEMOLISH PLASTER FROM EXISTING MASONRY WALL THIS AREA, REFER TO PLASTER REPAIR SCOPE FOR EXTENTS AND REQUIREMENTS. HATCH INDICATES APPROXIMATE EXTENT OF SLAB DEMOLITION FOR DEPRESSED SLAB AT NEW WALK-IN COOLERS - COORDINATE DIMENSIONS WITH SIZE AND REQUIREMENTS OF HATCH INDICATES APPROXIMATE EXTENTS OF SLAB DEMOLITION TO CUT, CAP AND ABANDON SANITARY PIPING BELOW SLAB. PATCH AND REPAIR SLAB PER STRUCTURAL REPAIR EXISTING VERTICAL CONDUIT TRENCH TO BE REUSED. CLEAR AWAY DEBRIS AND CUT WHERE NECESSARY TO FIT NEW CONDUIT AND BOXES. SEE DETAILS A512. HATCH INDICATES APPROXIMATE EXTENTS OF SLAB DEMOLITION FOR NEW BELOW-SLAB GREASE INTERCEPTOR. COORDINATE WITH PLUMBING DRAWINGS. REMOVE TOP PART OF EXISTING BRICK SHAFT WALL AFTER CONSTRUCTION OF CMU WALL BESIDE. SEE SHEET A515 FOR SHAFT DETAILS

DEMOLITION PLAN - LEVEL 1



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DEMOLITION PLAN -LEVEL 2

AD102

EXISTING CONSTRUCTION TO REMAIN

EXISTING DOOR AND

FRAME/CASING TO REMAIN

__ __ _ _ ITEM / CONSTRUCTION
TO BE REMOVED, SALVAGED
OR REINSTALLED

DEMOLISH DOOR AND FRAME

DEMOLISH DOOR LEAF ONLY EXISTING FRAME/CASING TO
REMAIN

EXTENT OF SLAB/FLOOR REMOVAL
REFER TO PLUMBING DRAWINGS FOR
EXTENT OR SLAB CUTS AND
PATCHING REQURED FOR
UNDERSLAB UTILITY INSTALLATION

GENERAL DEMO NOTES

AND OTHER RUNNING TRIM THROUGHOUT):

RELATED HARDWARE.

DOORS, FRAMES AND RELATED HARDWARE.

- 1. DASHED LINES INDICATE EXISTING CONSTRUCTION TO BE REMOVED U.N.O., REMOVAL OF PARTITIONS INCLUDES REMOVAL OF ALL ITEMS FIXED TO PARTITIONS (DOORS, CASEWORK, ELECTRICAL, PLUMBING, ETC). EXTENT OF SELECTIVE DEMOLITION SHALL BE AS REQUIRED FOR INSTALLATION OF NEW WORK. EXISTING WORK TO REMAIN, IF DAMAGED BY DEMOLITION OPERATIONS, SHALL BE REPAIRED TO MATCH ORIGINAL SURFACE CONDITION OR AS INDICATED IN THE DRAWINGS.
- PRIOR TO REMOVAL OR MODIFICATION OF WALLS OR OTHER LOAD BEARING ELEMENTS, THE ACTUAL SIZE AND LOCATION OF THE STRUCTURAL COMPONENTS AND LOAD BEARING CONDITIONS SHALL BE VERIFIED BY THE CONTRACTOR BY MEANS OF SELECTIVE DEMOLITION. THE CONTRACTOR SHALL NOTIFY THE ARCHITECT/ENGINEER OF ANY UNUSUAL OR HAZARDOUS CONDITION INCLUDING BUT NOT LIMITED TO CRACKS, ABSENCE OF BRACING, OR LOOSE ELEMENTS AND COMPONENTS.
- CONTRACTOR SHALL PROVIDE TEMPORARY BRACING AND SHORING REQUIRED TO SAFELY SUPPORT ALL LOADS, INCLUDING ROOF LOADS, AND TO MAINTAIN EXISTING FRAMING TO REMAIN IN ITS EXISTING LOCATION WHILE MAKING MODIFICATIONS REQUIRED UNDER THIS CONTRACT.
- 4. REFERENCE CIVIL DRAWINGS FOR REMOVAL OF SITE ELEMENTS INCLUDING, BUT NOT LIMITED TO WALKS, ROADS, PAVED AREAS, UTILITIES, GRADING AND LANDSCAPING.
- THE BULK OF ALL MECHANICAL, PLUMBING, AND ELECTRICAL EQUIPMENT, FIXTURES, WIRING, PIPING, ETC. HAVE BEEN REMOVED FROM THE BUILDING. REMAINING EQUIPMENT TO BE DEMOLISHED IS INDICATED ON DEMOLITION PLANS. EXISTING ABANDONED PIPING AND CONDUIT SHALL BE CAPPED IN CONCEALED LOCATIONS AFTER BEING SECURED IN PLACE.
- TYPICAL WALL AND/OR PARTITION DEMOLITION, UNLESS NOTED OTHERWISE, SHALL BE AS FOLLOWS:

 A. WALLS/PARTITIONS: REMOVE ENTIRELY WHERE SHOWN DASHED. WHERE WALLS ARE INDICATED TO REMAIN, REMOVE ALL ITEMS MOUNTED TO WALL. AT INTERSECTIONS OF ONE OR MORE WALLS TO BE REMOVED OR WHERE NEW DOOR AND WINDOW OPENINGS ARE CUT, REPAIR REMAINING EXPOSED WALL SURFACES WITH SAME MATERIAL TO MATCH ADJACENT SURFACE CONDITION. WHERE PORTIONS OF EXISTING MASONRY WALLS ARE TO BE REMOVED OR ADDED, REPAIR WALLS BY TOOTHING IN NEW MASONRY MATCHING DIMENSIONS OF EXISTING.

 B. WHERE PARTIONS EXTEND BELOW FLOOR, REMOVE PARTITIONS TO 8" MINIMUM BELOW FLOOR AND REPAIR EXISTING CONCRETE SLAB OR PATCH SUBFLOOR WITH NEW SUBFLOOR MATERIAL
- AT EXISTING TO REMAIN WALLS AND/OR PARTITIONS:

 A. REMOVE LOOSE PLASTER FROM ALL WALL SURFACES UNTIL ONLY SOUND MATERIAL SUITABLE FOR APPLICATION OF NEW PLASTER FINISH COATS REMAIN.

 B. REMOVE PLASTER THAT IS APPLIED OVER METAL LATH. REMOVE METAL LATH AND FASTENERS IN ITS ENTIRETY

 C. REMOVE LOOSE, FLAKING AND UNSOUND PAINT AND OTHER COATINGS FROM WALL SURFACES
- A. REMOVE ANY TRIM PIECES THAT ARE LOOSE OR NOT OTHERWISE FULLY SECURE TO SUBSTRATES. SALVAGE FOR REUSE.
 B. REMOVE ALL LOOSE, FLAKING, OR OTHERWISE COMPROMIZED PAINT/COATINGS FROM ALL WOOD TRIM SURFACES TO PREPARE FOR REPAINTING

WHERE BOTH DOORS AND FRAMES ARE INDICATED OR SCHEDULED TO BE DEMOLISHED, REMOVE

WHERE DOOR LEAF ONLY IS INDICATED OR SCHEDULED TO BE DEMOLISHED, REMOVE DOORS AND

WOOD TRIMWORK AND CASING (DOOR AND WINDOW CASINGS, CHAIR RAIL, PICTURE RAILS, CHALK TRAYS

- 10. GRIND SMOOTH AND PATCH EXISTING FLOOR WITH FLOOR LEVELING COMPOUND AND AS REQUIRED IN ALL AREAS WHERE ADJACENT SLABS ARE NOT LEVEL AFTER REMOVAL OF WALLS. PREPARE FOR INSTALLATION OF NEW FINISHES.
- 1. COORDINATE REMOVAL OF SLAB ON GRADE AS REQUIRED FOR INSTALLATION OF NEW SANITARY AND STORM PIPING AND CONNECTIONS TO EXISTING IN OR BELOW SLAB WORK. REFERENCE PLUMBING DRAWINGS FOR UNDER-SLAB PIPE LOCATIONS AND ROUTING. REFERENCE STRUCTURAL DRAWINGS FOR SLAB REPAIR DETAILS.
- WHERE RECESSED ELECTRICAL BOXES FOR RECEPTACLES, SWITCHES AND/OR OTHER DEVICES ARE ABANDONDED IN-PLACE, REMOVE BOX TO EXTENTS NECESSARY TO PATCH WALL MATERIAL TO MATCH ADJACENT FINISHED SURFACES BY PATCHING PLASTER, DRYWALL OTHER MATERIAL MATCHING EXISTING CONSTRUCTION AND MATERIAL.
- DIMENSIONS SHOWN IN DEMOLITION DRAWINGS ARE APPROXIMATE TO FINISHED FACE OF NEW OPENING U.N.O. CONTRACTOR TO COORDINATE EXTENT OF DEMO NECESSARY WITH NEW WORK.

 14. ELEVATOR DEMOLITION:
 - A. ALL COMPONENTS OF ELEVATOR, INCLUDING BUT NOT LIMITED TO CAB, CABLES, RAILS, JACKSHAFT, HYDRAULIC LINES AND EQUIPMENT, ELECTRONIC CONTROLS, DOORS, DOORFRAMES, DOOR SILLS, ETC. SHALL BE DEMOLISHED.

 B. ELEVATOR COMPONENENTS SHALL BE REMOVED FROM THE HOISTWAY THROUGH THE ELEVATOR DOOR OPENINGS. THE HOISTWAY SHAFT WALLS AND HOISTWAY SHAFT CAP SHALL NOT BE DAMAGED,
 - DEMOLISHED, OR OTHERWISE MODIFIED.

 AFTER REMOVAL OF HYDRAULIC JACK PISTON, FILL REMAINING HOLE IN SLAB WITH CONCRETE AND STRIKE FLUSH WITH PIT SLAB.

 DEMOLISH PORTION OF LEVEL 3 HOISTWAY WALL AS REQUIRED FOR INSTALLATION OF NEW ELEVATOR CONTROLS (JAMB-MOUNTED MACHINE-ROOM-LESS ELEVATOR CONTROLS) COORDINATE SCOPE AND EXTENTS WITH ELEVATOR INSTALLER.

 FILL REMAINING UN-USED HOLES, PENETRATIONS, GAPS, ETC. IN HOISTWAY WALLS WITH FIRESTPOPING
- COMPONENTS,

 15. REFER TO CIVIL PLANS FOR DEMOLITION OF SITE ELEMENTS
- REMOVE ALL EXISTING DEVICES, NAILS, FASTENERS, ANCHORS, HANGERS OR OTHER ITEMS (EXCLUSIVE OF WOOD TRIM AND OTHER HISTORIC BUILDING ELEMENTS) SECURED TO WALLS THAT ARE NOT INDICATED TO REMAIN. PATCH HOLES.

WHERE NOT REUSED FOR INSTALLATION OF NEW ELEVATOR AND ASSOCIATED ELECTRICAL

17. REMOVE PLYWOOD PANELS SCREWED DOWN TO EXISTING SUBFLOOR THROUGHOUT LEVEL 3. PANELS WERE INSTALLED BY ROOF CONTRACTOR AND LEFT IN PLACE TO PROVIDE SAFE WALKING ENVIRONMENT UNTIL CONSTRUCTION START

18. EXISTING CHILLER LOCATED AT NORTH-EAST CORNER OF SITE WITHIN FENCE ENCLOSURE: CONTRACTOR SHALL DISCONNECT CHILLER FROM ELECTRICAL AND PIPING SYSTEMS AND TRANSPORT TO 2325 MAURY STREET, RICHMOND, VA 23224

KEYNOTES

02.05	REMOVE EXISTING RUBBER STAIR TREADS AT STAIRS AND LANDINGS, TYP
02.09	DEMOLISH SLATE TREADS, TYP
02.20	DEMOLISH METAL PIPE GUARD RAIL AND/OR HANDRAIL. CORE DRILL TO REMOVE PORTION OF PIPE ANCHORED IN CURB AND REMOVE TO ALLOW INSTALLATION OF NEW RAIL IN EXISTING LOCATIONS.
02.23	DEMOLISH PLASTER FROM EXISTING MASONRY WALL THIS AREA, REFER TO PLASTER REPAIR SCOPE FOR EXTENTS AND REQUIREMENTS.
02.26	DEMOLISH WOOD DOOR TRIM AND CASING AT OPENING
02.29	DEMOLISH EXISTING CONCRETE EQUIPMENT PAD. PATCH AND REPAIR SLAB AS REQUIRED FOR INSTALLATION OF NEW FINISHES.
02.38	DEMOLISH EXISTING PYROBLOCK SHAFT AT LEVEL 3 AND AT TOP PART OF LEVEL 2 (11'-4" FROM FINISH FLOOR). COORDINATE EXTENTS OF DEMOLITION WITH INSTRUCTION OF NEW WORK. SEE SHAFT SECTIONS.
02.44	DEMOLISH EXISTING WALL-MOUNTED HEATER. PATCH PARTITION AS NECESSARY
02.45	EXISTING FRAME TO REMAIN
02.49	DEMOLISH EXISTING WIRING RACEWAYS EMBEDDED IN EXISTING PLASTER, WHERE NEW WIRING RACEWAY IS TO BE INSTALLED. COORDINATE WITH NEW WORK PLANS. TYPICAL AT CLASSROOM DOORS. ALL LOCATIONS MAY NOT BE INDICATED ON PLANS.
02.55	EXISTING DOOR OPENING. DEMOLISH REMNANTS OF EXISTING DAMAGED FRAME AND CASING - PREPARE OPENING TO RECEIVE NEW DOOR, FRAME AND CASING
02.56	DEMOLISH OVERHEAD MEZZANINE LEVEL FLOOR JOISTS, FRAMING AND FLOORING
02.59	DEMOLISH EXISTING PYROBLOCK CHASEWALL AND FINISHES IN ITS ENTIRETY.
02.63	EXISTING SLIDING DOOR AND TRACK SYSTEM: REMOVE DOOR (WHERE EXISTING) AND SALVAGE FOR RESTORATION. DEMOLISH ENTIRE DOOR TRACK. STEEL SUPPORT STRUCTURE (STEEL CHANNEL AND PLATE) SHALL REMAIN IN PLACE AND SUPPORTED AS REQUIRED DURING DEMOLITION OF EXISTING ADJACENT SHAFTS AND CONSTRUCTION OF NEW WALLS. EXISTING WOOD TRIM SHALL BE SUPPORTED IN PLACE OR REMOVED AND REINSTALLED, AS REQUIRED TO CARRY OF NEW WORK
02.64	REMOVE LOUVER, INFILL MASONRY WALL WITH CMU, AND PATCH WITH PLASTER.
02.66	DEMOLISH ELEVATOR HYDRAULIC AND ELECTRICAL CONTROL COMPONENTS, WIRING, BOXES AND CONDUIT. PATCH ALL REMAINING HOLES IN HOISTWAY SHAFT WALLS UNLESS PENETRATIONS ARE TO BE REUSED TO SERVE NEW ELEVATOR.

DEMOLISH DAMAGED EXTERIOR INSULATED FINISH SYSTEM PANEL. PREPARE FOR INSTALLATION OF NEW FINISH.

DEMOLISH ELEVATOR DOOR ASSEMBLY AND RELATED COMPONENTS TO PREPARE FOR NEW ELEVATOR DOOR INSTALLATION.

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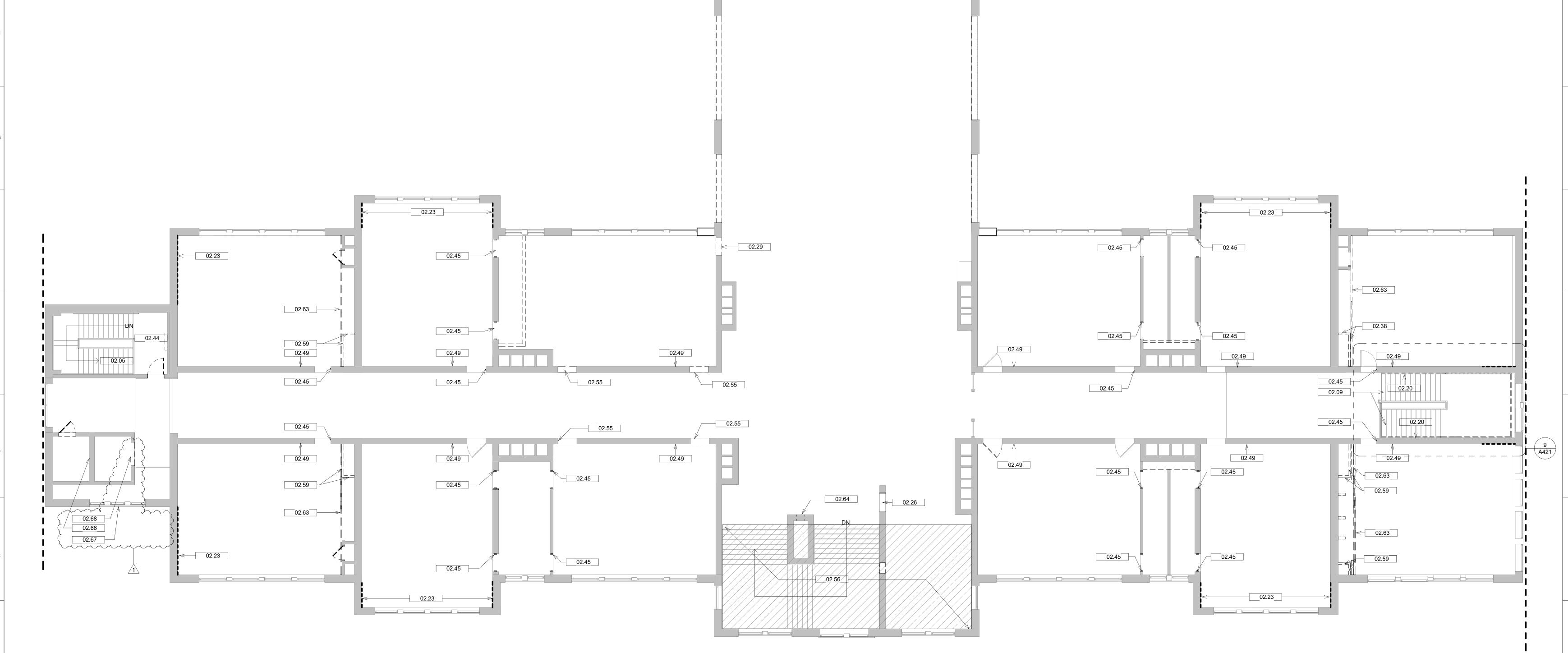
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WILLIAM FOX

STATE PROJECT No: 123-20-00-101



1 DEMOLITION PLAN - LEVEL 3
AD103 1/8" = 1'-0"

1 10/18/2023 ADDENDUM 001

PROJECT MANAGER: DRAWN BY:

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BID DOCUMENTS 10/3/2023

DEMOLITION PLAN -LEVEL 3

AD103

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PANEL "ELLS" LA-39 VIA L/C-A INSTRUMENT TOILET
116

CUSTODIAL
OFFICE
117 A ——— 8 8 GIRLS TOILET 8 8 1 SP. OFFICE ED 121 122 2 CLASSROOM TEACHER WORKROOM 108 BOOK STORAGE-126 ELLS-8 ELEVATOR 9 9 9 9 9 9 9 9 9 9 9 E1 COLD STORAGE 104b SPECIAL 8 8 8 8 5 5 MECHANICAL BOILER ROOM – 101a

PANEL "LA"

BAND/ORCHESTRA

LEVEL 1 FLOOR PLAN - LIGHTING 2

SCALE: 1/8" = 1'-0"

CONSTRUCTION NOTES: (THIS DRAWING ONLY)

1 CONNECT THIS LIGHT FIXTURE TO EMERGENCY CIRCUIT VIA EMERGENCY POWER CONTROL DEVICE. SEE "EMERGENCY POWER CONTROL DEVICE DIAGRAM" ON DRAWING E003 FOR ADDITIONAL INFORMATION.

ALL CONDUITS SHALL BE RUN EXPOSED ON THIS FLOOR PLAN. RUN CONDUITS GROUPED TOGETHER WHERE POSSIBLE TO MINIMIZE SINGLE CONDUITS. COORDINATE ALL CONDUIT PATHWAYS WITH ARCHITECTURAL DRAWINGS TO ENSURE THE BEST ROUTING.

3 DOWN TO RECEPTACLE SEE DRAWING E201 FOR CONTINUATION.

4 INTERLOCK ALL OCCUPANCY SENSORS IN THIS SPACE SUCH THAT WHEN ANY SENSOR IS ACTIVATED, IT WILL ENERGIZE LIGHTING CIRCUIT IN THIS SPACE.

SPACE.

5 UP TO LIGHT FIXTURES AT TOP OF ELVATOR SHAFT, SEE DRAWING E103 FOR CONTINUATION.

1 10/18/2023 ADDENDUM 001

No. Date Description
PROJECT MANAGER: DRAWN

QEA No.42240940

BID DOCUMENTS 10/3/2023

FLOOR PLAN LEVEL 1 -LIGHTING

E101

RICHMOND PUBLIC SCHOOLS

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1 10/18/2023 ADDENDUM 001

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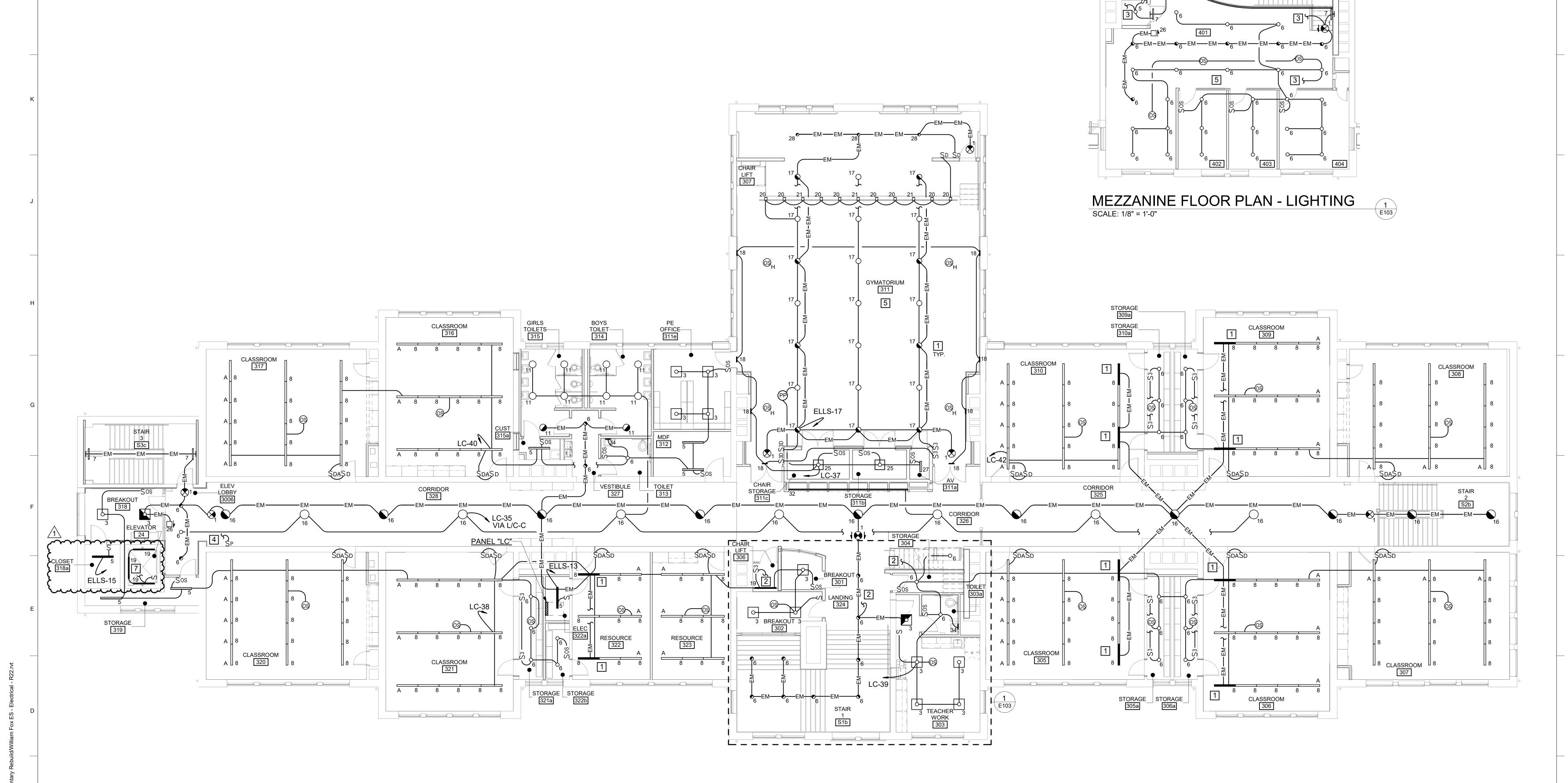
QEA No.42240940

PROJECT MANAGER:

BID DOCUMENTS 10/3/2023

FLOOR PLAN LEVEL 3 -LIGHTING

F103



LEVEL 3 FLOOR PLAN - LIGHTING 6 SCALE: 1/8" = 1'-0"

CONSTRUCTION NOTES

NSTRUCTION NOTES (THIS DRAWING ONLY)

1 CONNECT THIS LIGHT FIXTURE TO EMERGENCY CIRCUIT VIA EMERGENCY POWER CONTROL DEVICE. SEE "EMERGENCY POWER CONTROL DEVICE DIAGRAM" ON DRAWING E003 FOR ADDITIONAL INFORMATION.

2 UP TO "MEZZANINE FLOOR PLAN - LIGHTING", SEE THIS DRAWING FOR CONTINUATION.

3 DOWN TO "LEVEL 3 FLOOR PLAN - LIGHTING", SEE THIS DRAWING FOR CONTINUATION.

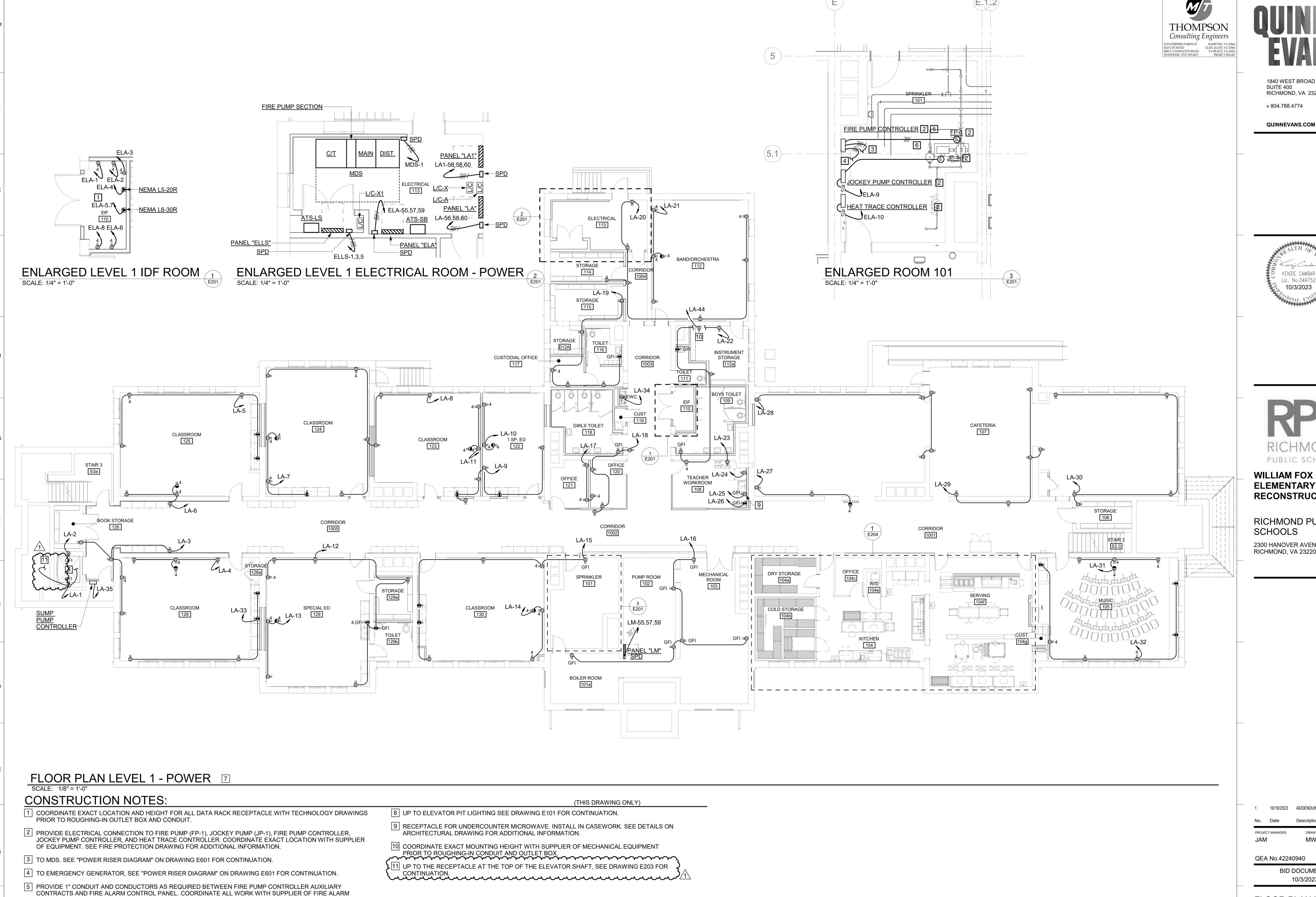
4 UP TO LIGHT FIXTURE IN ATTIC, SEE DRAWING E104 FOR CONTINUATION.

5 INTERLOCK ALL OCCUPANCY SENSORS IN THIS SPACE SUCH THAT WHEN ANY SENSOR IS ACTIVATED, IT WILL ENERGIZE LIGHTING CIRCUIT IN THIS SPACE.

6 SEE DRAWING E101 FOR LOCATION OF PANEL "ELLS".

7 DOWN TO LIGHT FIXTURES AT BOTTOM OF ELEVATOR SHAFT, SEE DRAWING E101 FOR CONTINUATION.

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CONTROL PANEL TO MONITOR FIRE PUMP.

DRAWINGS TO ENSURE THE BEST ROUTING.

CONTINUATION.

6 PROVIDE 3 #3 AND 1 #8 GND. IN 2" CONDUIT. SEE "POWER RISER DIAGRAM" ON DRAWING E601 FOR

7 ALL CONDUITS SHALL BE RUN EXPOSED ON THIS FLOOR PLAN. RUN CONDUITS GROUPED TOGETHER WHERE POSSIBLE TO MINIMIZE SINGLE CONDUITS. COORDINATE ALL CONDUIT PATHWAYS WITH ARCHITECTURAL

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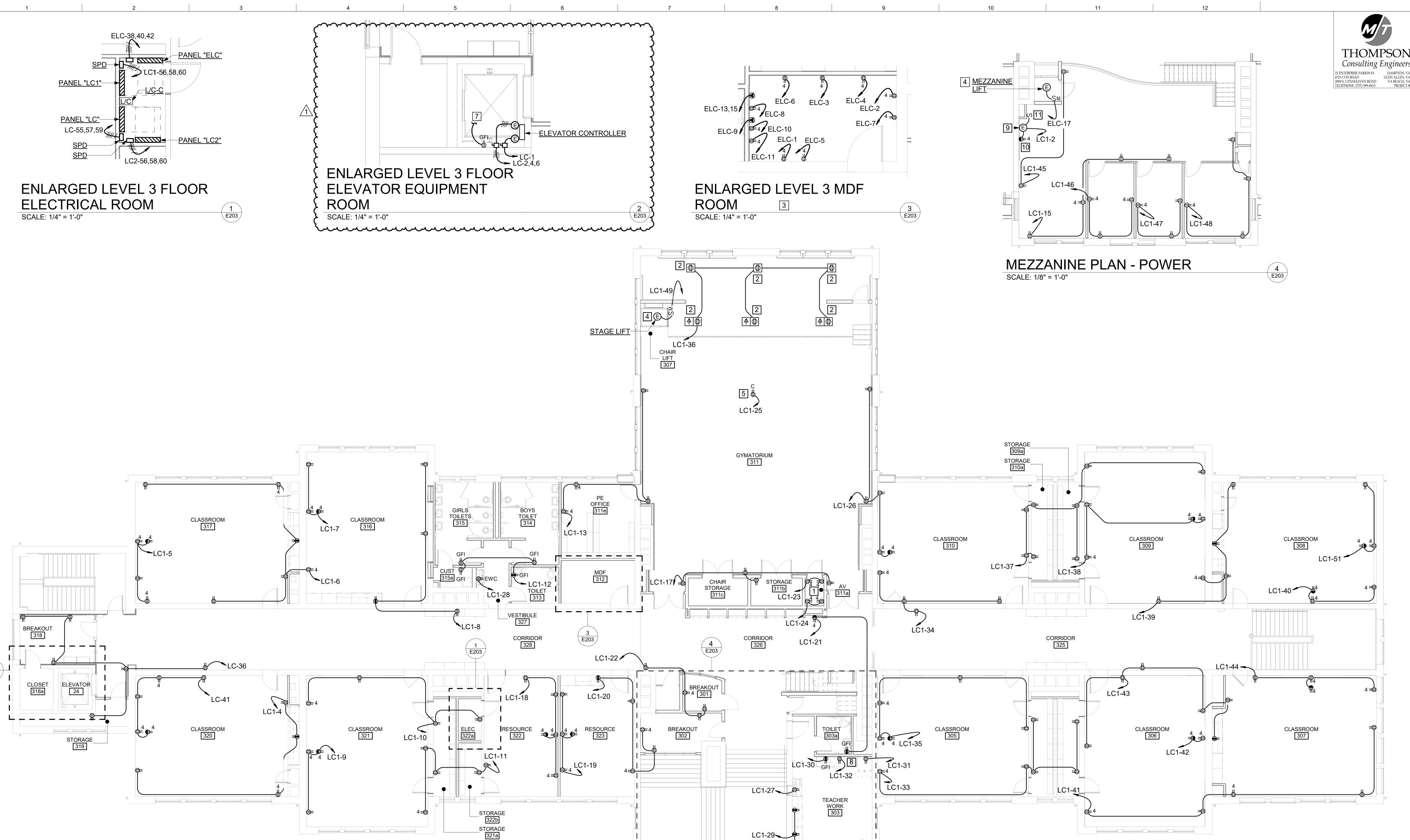
1 10/18/2023 ADDENDUM 001

PROJECT MANAGER:

QEA No.42240940

BID DOCUMENTS 10/3/2023

FLOOR PLAN LEVEL 1 -POWER



LC1-29

FLOOR PLAN LEVEL 3 - POWER SCALE: 1/8" = 1'-0"

CONSTRUCTION NOTES:

1 INSTALL ALL RECEPTACLES AT +36" A.F.F. COORDINATE EXACT LOCATION WITH AV AND MOTERIZED SHADE SUPPLIER DRAWINGS PRIOR TO ROUGHING-IN OUTLET BOX AND CONDUIT.

2 INSTALL RECEPTACLE IN AV FLOOR BOX. COORDINATE EXACT LOCATION WITH AV DRAWINGS PRIOR TO

ROUGHING-IN OUTLET BOX AND CONDUIT. 3 COORDINATE EXACT LOCATION AND HEIGHT FOR ALL DATA RACK RECEPTACLE WITH TECHNOLOGY DRAWINGS

PRIOR TO ROUGHING-IN OUTLET BOX AND CONDUIT. 4 COORDINATE EXACT LOCATION OF ELECTRICAL CONNECTION WITH SUPPLIER OF LIFT PRIOR TO INSTALLATION.

5 INSTALL RECEPTACLE IN CEILING. COORDINATE EXACT LOCATION WITH A/V DRAWINGS PRIOR TO ROUGHING-IN CONDUIT AND OUTLET BOX. PROVIDE CONNECTION TO PROJECTOR LIFT AND CONNECT TO SAME CIRCUIT AS

ᢧᠬᢇᠬᢇᠬᢇᠬ᠇ᢇᠬ᠇ᠬ᠇ᠬ᠇ᠬ᠇ᠬ᠇ᠬ᠇ᠬ᠇ᠬ᠇ᠬ᠇ᠬ᠇ᠬᢇᠬ 6 COORDINATE EXACT LOCATION OF EQUIPMENT AND ELECTRICAL CONNECTION WITH OWNER, ARCHITECT, AND ELEVATOR REPRESENTATIVE.

7 DOWN TO RECEPTACLE AT THE BOTTOM OF THE ELEVATOR SHAFT, SEE DRAWING E201 FOR CONTINUATION RECEPTACLE FOR UNDERCOUNTER MICROWAVE. SEE DETAILS ON ARCHITECTURAL DRAWINGS FOR ADDITIONAL 8 INFORMATION.

(THIS DRAWING ONLY) 9 PROVIDE ELECTRICAL CONNECTION TO PROJECTOR SCREEN. COORDINATE WORK WITH EQUIPMENT PROVIDER.

[10] COORDINATE EXACT HEIGHT OF RECEPTACLE FOR PROJECTOR WITH THE ARCHITECT. PROJECTOR PROVIDED BY OWNER; INSTALLED BY CONTRACTOR.

11 PROVIDE OUTLET BOX FOR PROJECTION SCREEN RAISE/LOWER SWITCH. INSTALL OUTLET BOX +48" A.F.F. PROVIDE 3/4" CONDUIT FROM OUTLET BOX TO PROJECTOR SCREEN, PROVIDE OUTLET BOX SIZE AND CONDUCTORS AS DIRECTED BY EQUIPMENT SUPPLIER. PROJECTION SCREEN RAISE/LOWER SWITCH, FURNISHED

BY EQUIPMENT SUPPLIER. INSTALL AS DIRECTED BY EQUIPMENT SUPPLIER.

Consulting Engineers 22 ENTERPRISE PARKWAY
4323 COX ROAD
2809 S. LYNNHAVEN ROAD
TELEPHONE: (757) 599-4415

HAMPTON, VA 23666
GLEN ALLEN, VA 23060
VA BEACH, VA 23452
PROJECT #22-067

> 1840 WEST BROAD STREET SUITE 400 RICHMOND, VA 23220

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v 804.788.4774

KENZIE CAMBAR Lic. No.049752 10/3/2023

PUBLIC SCHOOLS

WILLIAM FOX ELEMENTARY SCHOOL RECONSTRUCTION

RICHMOND PUBLIC SCHOOLS 2300 HANOVER AVENUE

RICHMOND, VA 23220

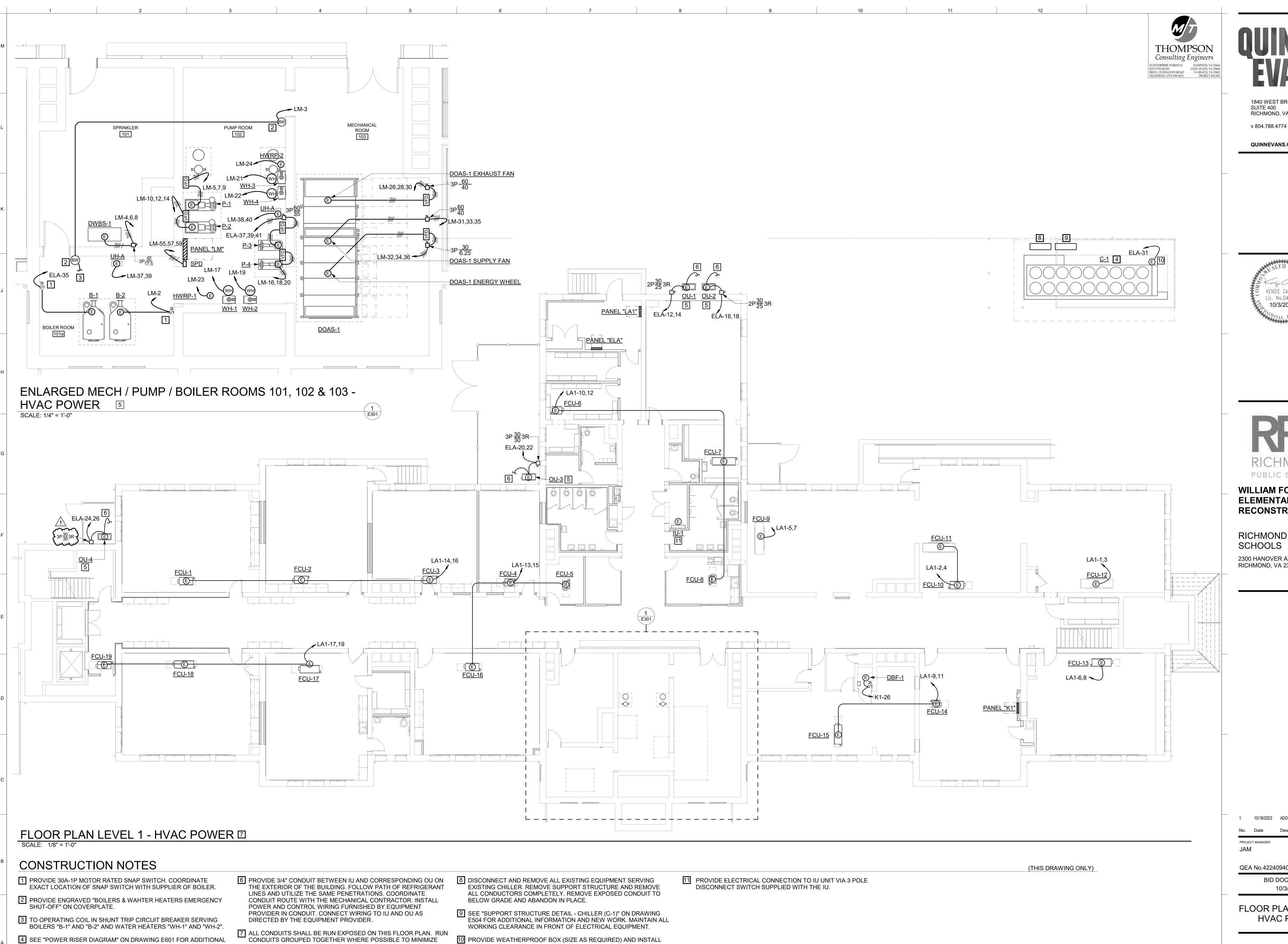
1 10/18/2023 ADDENDUM 001

PROJECT MANAGER:

QEA No.42240940

BID DOCUMENTS 10/3/2023

FLOOR PLAN LEVEL 3 -**POWER**



ON EXTERIOR WALL FOR CONNECTION TO HEAT TRACE.

EQUIPMENT.

COORDINATE EXACT TERMINATION WITH SUPPLIER OF HEAT TRACE

INFORMATION.

5 COORDINATE EXACT LOCATION OF ELECTRICAL CONNECTION WITH

SUPPLIER OF EQUIPMENT PRIOR TO INSTALLATION OF CONDUIT.

SINGLE CONDUITS. COORDINATE ALL CONDUIT PATHWAYS WITH

ARCHITECTURAL DRAWINGS TO ENSURE THE BEST ROUTING.

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1 10/18/2023 ADDENDUM 001

PROJECT MANAGER:

QEA No.42240940

BID DOCUMENTS 10/3/2023

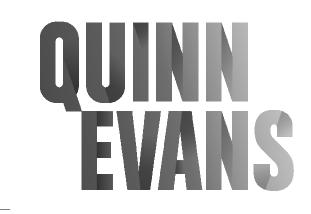
FLOOR PLAN LEVEL 1 -**HVAC POWER**



P 4 P 4 P 4 P

b d

b d b



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FLOOR PLAN LEVEL 3 - HVAC POWER

SCALE: 1/8" = 1'-0"

PANEL "LC1"

PANEL "LC"

PANEL "LC2"

E 1U-3

P 4 P 4 P 4

CONSTRUCTION NOTES (THIS DRAWING ONLY)

1 PROVIDE 30A - 2P MOTOR RATED SNAP SWITCH. COORDINATE EXACT LOCATION WITH SUPPLIER OF WATER HEATER.

2 PROVIDE ELECTRICAL CONNECTION TO IU UNIT VIA 3 POLE DISCONNECT SWITCH SUPPLIED WITH THE IU.

1 10/18/2023 ADDENDUM 001

No. Date Description

PROJECT MANAGER: DRAWN BY:

QEA No.42240940

BID DOCUMENTS 10/3/2023

FLOOR PLAN LEVEL 3 -HVAC POWER

=303



FCU-74

b d b d

RICHMOND PUBLIC SCHOOLS

WILLIAM FOX ELEMENTARY SCHOOL RECONSTRUCTION

RICHMOND PUBLIC SCHOOLS

2300 HANOVER AVENUE RICHMOND, VA 23220

W EL RI

FCU-59 LC2-30,32 FCU-60

LC2-33,35

LC2-26,28 FCU-61

LC2-21,23

ATTIC PLAN LEVEL 4 - HVAC POWER 1 4

SCALE: 1/8" = 1'-0"

CONSTRUCTION NOTES

(THIS DRAWING ONLY)

 $33P\frac{30}{25}$

3 4 5 6 7 8 9 10 11

1 SEE DRAWING E303 FOR LOCATION OF PANEL "LC" AND "LC2".

2 PROVIDE A RECEPTACLE SURFACE MOUNTED IN A SURFACE MOUNTED OUTLET BOX ON FLOOR. COORDINATE LOCATION SO RECEPTACLE AND CONDUIT IS NOT IN WALKING AREA.

3 PROVIDE UNSTRUCT FLOOR MOUNTED SUPPORT STRUCTURE FOR MOUNTING OF ALL DISCONNECT SWITCHES AND VARIABLE FREQUENCY DRIVES (VFD).

4 COORDINATE EXACT LOCATION OF ELECTRICAL CONNECTION WITH SUPPLIER OF EQUIPMENT PRIOR TO ROUGHING-IN CONDUIT.

5 SEE KITCHEN DRAWING E204 FOR CONTINUATION.

1 10/18/2023 ADDENDUM 001

No. Date Description

PROJECT MANAGER: DRAWN BY:

QEA No.42240940

BID DOCUMENTS 10/3/2023

ATTIC PLAN LEVEL 4 -HVAC POWER

E304

TOTAL ESTIMATED DEMAND LOAD (KVA): 7 kVA

TOTAL CONNECTED LOAD (KVA): 7 kVA

1. PROVIDE PANEL WITH FEED-THRU LUGS.

MOUNTING: Surfa	ce				V PH	OLTS	5: 120/ 5: 3		V ye		I	M	AINS TYPE: MLO	
LOAD SERVED	Р	C/B TRIP	WIRE SIZE	,	A	ı	В		C			Р	LOAD SERVED	CI
RECEPTACLES	1	20	12	10.0	10.0					12	20	1	RECEPTACLES	2
DECEDIACIE		20	40			24.0	10.0			12	20	1	RECEPTACLE	4
RECEPTACLE	2	30	10					24.0	10.0	12	20	1	RECEPTACLES	(
RECEPTACLES	1	20	12	10.0	10.0					12	20	1	RECEPTACLES	
SPACE	1						0.0				20	1	SPARE	1
SPACE	1								0.0		20	1	SPARE	1
SPACE	1				0.0						20	1	SPARE	1
SPACE	1											1	SPACE	1
SPACE	1											1	SPACE	1
SPACE	1				1.0									2
SPACE	1						1.0			10	30	3	SPD	2
SPACE	1								1.0					2
														1
	MOUNTING: Surfa NEMA: Type LOAD SERVED RECEPTACLES RECEPTACLE RECEPTACLES SPACE SPACE	RECEPTACLES 1 RECEPTACLE 2 RECEPTACLES 1 SPACE 1 CONNECTED LO	MOUNTING: Surface NEMA: Type 1 LOAD SERVED P C/B TRIP RECEPTACLES 1 20 RECEPTACLE 2 30 RECEPTACLES 1 20 SPACE 1 CONNECTED LOAD (A	MOUNTING: Surface NEMA: Type 1 LOAD SERVED P C/B TRIP SIZE WIRE TRIP SIZE RECEPTACLES 1 20 12 RECEPTACLE 2 30 10 RECEPTACLES 1 20 12 SPACE 1 SPACE 1	MOUNTING: Surface NEMA: Type 1 LOAD SERVED P C/B TRIP SIZE WIRE SIZE RECEPTACLES 1 20 12 10.0 RECEPTACLE 2 30 10	LOCATION: ELEC 231a MOUNTING: Surface NEMA: Type 1 P C/B TRIP SIZE A	LOCATION: ELEC 231a MOUNTING: Surface NEMA: Type 1 P C/B WIRE SIZE A WIRES	LOCATION: ELEC 231a MOUNTING: Surface NEMA: Type 1 LOAD SERVED P C/B TRIP SIZE A B RECEPTACLES 1 20 12 10.0 10.0 RECEPTACLES 1 20 12 10.0 10.0 RECEPTACLES 1 20 12 10.0 10.0 SPACE 1 0.0 SPACE 1 1.0 SPACE 1 1.0	MOUNTING: Surface NEMA: Type 1 WIRES: 3 WIRES: 4	LOCATION: ELEC 231a MOUNTING: Surface NEMA: Type 1	LOCATION: ELEC 231a MOUNTING: Surface NEMA: Type 1 P	LOCATION: ELEC 231a MOUNTING: Surface NEMA: Type 1 WIRE S: 3 WIRES: 4 LOAD SERVED P TRIP SIZE A B C WIRE SIZE TRIP RECEPTACLES 1 20 12 10.0 10.0 12 20 12 20	LOCATION: ELEC 231a WOLTS: 120/208 Wye PHASES: 3 WIRE SIZE A B C WIRE C/B PHASES: 3 WIRE C/B PHASES: 3 WIRE C/B PHASES: 4 MAIN MAIN	LOCATION: ELEC 231a MOUNTING: Surface NEMA: Type 1

1. PROVIDE PANEL WITH FEED-THRU LUGS.

LOAD SERVED	Р				PH	VOLTS HASES WIRES	S: 3)/208 W	<i>l</i> ye		l	MA	IC RATING: 10 AINS TYPE: MLO IS RATING: 400 A	
3 RECEPTACLES 5 RECEPTACLES 7 RECEPTACLES 9 RECEPTACLE 11 RECEPTACLES 13 RECEPTACLE 15 MEZZANINE LIFT 19 SPACE 21 SPACE 23 SPACE 25 SPACE 27 SPACE 29 SPACE 31 SPACE 33 SPACE 35 SPACE			WIRE		A	ſ	В	•	С	WIRE SIZE		Р	LOAD SERVED	CK1 NO
5 RECEPTACLES 7 RECEPTACLES 9 RECEPTACLE 11 RECEPTACLES 13 RECEPTACLE 15 MEZZANINE LIFT 19 SPACE 21 SPACE 23 SPACE 25 SPACE 27 SPACE 29 SPACE 31 SPACE 33 SPACE 35 SPACE	1	20	12	10.0	10.0					12	20	1	RECEPTACLE	2
7 RECEPTACLES 9 RECEPTACLE 11 RECEPTACLES 13 RECEPTACLE 15 MEZZANINE LIFT 19 SPACE 21 SPACE 23 SPACE 25 SPACE 27 SPACE 29 SPACE 31 SPACE 31 SPACE 33 SPACE	1	20	12			10.0	10.0			12	20	1	RECEPTACLE	4
9 RECEPTACLE 11 RECEPTACLES 13 RECEPTACLE 15 MEZZANINE LIFT 19 SPACE 21 SPACE 23 SPACE 25 SPACE 27 SPACE 29 SPACE 31 SPACE 31 SPACE 33 SPACE	1	20	12					10.0	10.0	12	20	1	RECEPTACLE	6
11 RECEPTACLE 13 RECEPTACLE 15 MEZZANINE LIFT 19 SPACE 21 SPACE 23 SPACE 25 SPACE 27 SPACE 29 SPACE 31 SPACE 33 SPACE 35 SPACE	1	20	12	10.0	10.0					12	20	1	RECEPTACLE	8
13 RECEPTACLE 15 MEZZANINE LIFT 19 SPACE 21 SPACE 23 SPACE 25 SPACE 27 SPACE 29 SPACE 31 SPACE 33 SPACE 35 SPACE	1	20	12			10.0	10.0			12	20	1	RECEPTACLE	10
RECEPTACLE 15 MEZZANINE LIFT 19 SPACE 21 SPACE 23 SPACE 25 SPACE 27 SPACE 29 SPACE 31 SPACE 33 SPACE 35 SPACE	1	20	12					10.0	0.0		20	1	SPARE	12
15 17 MEZZANINE LIFT 19 SPACE 21 SPACE 23 SPACE 25 SPACE 27 SPACE 29 SPACE 31 SPACE 33 SPACE 35 SPACE		20	40	24.0	0.0						20	1	SPARE	14
19 SPACE 21 SPACE 23 SPACE 25 SPACE 27 SPACE 29 SPACE 31 SPACE 31 SPACE 32 SPACE 33 SPACE	2	30	10			24.0	0.0				20	1	SPARE	16
21 SPACE 23 SPACE 25 SPACE 27 SPACE 29 SPACE 31 SPACE 33 SPACE 35 SPACE	1	15	10					12.0	0.0		20	1	SPARE	18
23 SPACE 25 SPACE 27 SPACE 29 SPACE 31 SPACE 33 SPACE 35 SPACE	1											1	SPACE	20
25 SPACE 27 SPACE 29 SPACE 31 SPACE 33 SPACE 35 SPACE	1											1	SPACE	22
27 SPACE 29 SPACE 31 SPACE 33 SPACE 35 SPACE	1											1	SPACE	24
29 SPACE 31 SPACE 33 SPACE 35 SPACE	1											1	SPACE	26
31 SPACE 33 SPACE 35 SPACE	1											1	SPACE	28
33 SPACE 35 SPACE	1											1	SPACE	30
35 SPACE	1											1	SPACE	32
	1											1	SPACE	34
37 SPACE	1											1	SPACE	36
1 1	1				1.0							1		38
39 SPACE	1						1.0			10	30	3	SPD	40
41 SPACE	1		'						1.0	1 '				42
CONNEC			- +		5 A		5 A		3 A					
CONNE TOTAL CONNECTED LOAD (KVA): 20 kVA	CTED	LOAD ((KVA):	7 k	kVA	7 k	kVA		κVA				(VA): 20 kVA	



	LOCATION: ELECTRIC	AL 1	13					: EL		Vye			KA	IC RATING: 42	
	MOUNTING: Surface NEMA: Type 1						IASES VIRES	_				I		AINS TYPE: MLO IS RATING: 400 A	
CKT NO	LOAD SERVED	Р		WIRE SIZE		A		В		С	WIRE SIZE	C/B TRIP	Р	LOAD SERVED	CKT NO
1	RECEPTACLE	1	20	12	10.0	10.0					12	20	1	RECEPTACLE	2
3	RECEPTACLE	1	20	12			10.0	10.0			12	20	1	RECEPTACLE	4
5	DECEDIACI E		20	40					24.0	10.0	12	20	1	RECEPTACLE	6
7	RECEPTACLE	2	30	10	24.0	10.0					12	20	1	RECEPTACLE	8
9	JOCKEY PUMP CONTROLLER	1	20	10			7.2	5.0			10	20	1	HEAT TRACE CONTROLLER	10
11	WALK-IN COOLER LIGHTS	1	20	12					1.0	14.4	40	0.5	•	011.4	12
13	WALK-IN FREEZER LIGHTS & RECEPTACLE	1	20	12	3.0	14.4					10	25	2	OU-1	14
15							9.8	14.4							16
17	WALK-IN FREEZER UNIT COOLER	2	20	12					9.8	14.4	10	20	2	OU-2	18
19	WALK-IN COOLER UNIT COOLER	1	20	12	1.6	16.0				\wedge			_		20
21					^		1.0	16.0		1	10	30	2 ^	OU-3	22
23	WALK-IN FREEZER UNIT COOLER	2	20	12	<u>/1</u> `				1.0	20.0	3	~~~	<u>/1\</u>		24
25					10.0	20.0	3			~~	10	30	2	OU-4	26
27	JACKET WATER HEATER	2	20	10		~	10.0	10.0			12	20	1	BATTERY CHARGER	28
29	HEAT TRACE	1	20	8					10.0	10.0	8	20	1	CHILLER EVAPORATOR	30
31	HEAT TRACE CHILLER	1	20	8	10.0	25.8									32
33	RECEPTACLE	1	20	8			1.5	25.8			8	35	3	WALK-IN FREEZER CU	34
35	BOILER B-1 (SEE NOTE 2)	1	30	10					20.0	25.8					36
37			+		17.5	12.0									38
39	PUMP P-3	3	35	8	1110		17.5	12.0			12	15	3	WALK-IN COOLER CU	40
41									17.5	12.0					42
43	SPARE	1	20		0.0								1	SPACE	44
45	SPARE	1	20		0.0		0.0						1	SPACE	46
47	SPARE	1	20				0.0		0.0				1	SPACE	48
49	SPARE	1	20		0.0								1	SPACE	50
51	SPACE	1											1	SPACE	52
53	SPACE	1											1	SPACE	54
55	0.7.02	•			1.0								1	SPACE	56
57	SPD	3	30	10			1.0						1	SPACE	58
59	51 <i>D</i>		30				1.0		1.0				1	SPACE	60
33	CONNECT	ED L	OAD (A	MPS).	27	9 A	23	8 A		7 A			1	OI AGE	
	CONNECTED LOAD (KVA):					kVA		kVA		kVA	1				

TOTAL ESTIMATED DEMAND LOAD (KVA): 87 kVA

1. PROVIDE PANEL WITH FEED-THRU LUGS.

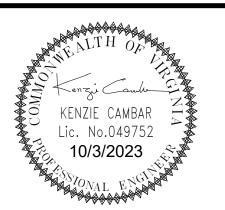
TOTAL CONNECTED LOAD (KVA): 91 kVA

2. PROVIDE SHUNT TRIP TYPE CIRCUIT BREAKER WITH 120V OPERATING COIL.



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RICHMOND PUBLIC SCHOOLS

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1 10/18/2023 ADDENDUM 001

QEA No.42240940

10/3/2023

BID DOCUMENTS

PANELBOARD SCHEDULES

E503

DRYER BOOSTER FAN SCHEDULE													
UNIT NO.	DUCT SIZE	CFM	WATTS	V	AMPS	PH	SELECTION BASED ON "FANTECH"	REMARKS					
DBF-1	4"	150	78	120	0.73	1	DBF 4XLT - 705	1 2					

SELECTION BASED

ON "MARKEL"

HF1B5103N

OPERATING

108

DRAIN CHECK VALVE.

EVAPORATOR UNIT.

(9) MEDIUM STATIC DUCTED INDOOR

REMARKS

12

REMARKS

12345678

12345678

23456789

REMARKS: (1) PROVIDE WITH INTEGRATED PRESSURE SWITCH.

| CAPACITY | ELECTRIC HEATING COIL

2.5 208

KW

OUTDOOR UNIT

"LENNOX"

MLA018S4S-1

MLA018S4S-1

MLA024S4S-1P | 20 | 30.0 | 208 |

| MLA024S4S-1P | 20 | 30.0 | 208 |

(5) CAPACITIES BASED ON 95°F DB / 78°F WB SUMMER, 47°F WINTER AMBIENT (8) PROVIDE WITH IN-LINE CONDENSATE

 $_{\perp}$ (1) PROVIDE WITH INTEGRAL THERMOSTAT AND FACTORY WIRED DISCONNECT SWITCH.

(2) PROVIDE INDICATOR PANEL AND LOCATE IN WALL NEXT TO DRYER. FIELD COORDINATE EXACT LOCATION WITH OWNER/ARCHITECT.

ELECTRIC UNIT HEATER SCHEDULE

V PH

11.9

| MCA | MOCP | V | PH | WEIGHT (LBS)

18 | 25.0 | 208 |

18 | 25.0 | 208 |

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HAMPTON, VA 23666 GLEN ALLEN, VA 23060 VA BEACH, VA 23452 PROJECT #22-067

1840 WEST BROAD STREET

SUITE 400 RICHMOND, VA 23220 v 804.788.4774

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6 KEVIN D. ALLEN Lic. No. 023349	
Syonal Exchange	

RECONSTRUCTION

SCHOOLS 2300 HANOVER AVENUE

RICHMOND, VA 23220

PUBLIC SCHOOLS **WILLIAM FOX ELEMENTARY SCHOOL**

RICHMOND PUBLIC

(4) REFER TO HEAT TRACE CABLE ORIENTATION DETAIL AND TYPICAL HEAT TRACE FITTINGS DETAIL.

(5) NUMBER OF CIRCUITS SHALL BE EQUAL TO THE NUMBER OF TERMINAL CONTROLLERS USED PER PIPE UNLESS OTHERWISE NOTED. TERMINAL CONTROLLER "TRACON FTP 130" OR APPROVED EQUAL. TERMINAL CONTROLLER SHALL HAVE INTEGRAL GROUND FAULT PROTECTION AND A BAS MONITORING POINT.

(6) REFER TO FIRE PROTECTION DRAWING F101 FOR HEAT TRACE REQUIREMENTS. FIRE PROTECTION HEAT TRACE CONTROLLER TO BE MONITORED BY DDC.

	BOILER SCHEDULE													
UNIT NO.	DESCRIPTION	INPUT (MBH)	OUTPUT (MBH)	FUEL TYPE	GPM	GAS PRESSURE (IN WC)	INTAKE VENT (IN.)	FLUE OUTLET (IN.)	H2O △T (°F)		PH	ICAL FLA	SELECTION BASED ON "FULTON"	REMARKS
B-1	HIGH EFFICIENCY GAS FIRED WATER BOILER	2,000	1,874	NATURAL GAS	102	4 - 28	8	8	40.0	208	3	20	EDR-2000	12345
B-2	HIGH EFFICIENCY GAS FIRED WATER BOILER	2,000	1,874	NATURAL GAS	102	4 - 28	8	8	40.0	208	3	20	EDR-2000	12345
				_				_						

PROVIDE 65 K.A.I.C. RATED.

MINIMUM IPLV TO BE 19.3

REMARKS: (1) PROVIDE WITH GALVANIZED STEEL INTAKE.

(2) PROVIDE STAINLESS STEEL "AL29-4C" EXHAUST FLUE.

(2) SELECTION BASED ON 95°F DB, 78°F WB AMBIENT CONDITIONS.

(3) PROVIDE WITH CONDENSATE NEUTRALIZER OR DILUTION TRAP BY BOILER MANUFACTURER.

(4) FULLY MODULATING BURNER, UP TO 10:1 TURNDOWN.

(5) COMBUSTION TEMPERATURE CONTROL PRECISION SHALL BE ±0.2°F.

PU	MP S	SCHEDULE		
			OFLECTION	

UNIT	TYPE	SYSTEM	GPM	HEAD	N	MOTOR	DAT	Ą	SELECTION BASED ON	REMARKS	
NO.	ITE	STOTEIN	GEIVI	TIEAD	HP	RPM	M V PH		"BELL & GOSSETT"	REWARKS	
P-1	BASE MOUNTED END SUCTION	CHILLED WATER	525	79	15	3471	208	3	E-1510 3AD	123	
P-2	BASE MOUNTED END SUCTION	CHILLED WATER (STAND-BY)	525	79	15	3471	208	3	E-1510 3AD	123	
P-3	BASE MOUNTED END SUCTION	HOT WATER	143	51	5	1522	208	3	E-1510 2BD	123	
P-4	BASE MOUNTED END SUCTION	HOT WATER (STAND-BY)	143	51	5	1522	208	3	E-1510 2BD	123	

REMARKS: (1) PROVIDE MATCHED SUCTION DIFFUSER.

(2) PROVIDE WITH VARIABLE FREQUENCY DRIVE MATCHED TO MOTOR HP.

(3) PROVIDE WITH PREMIUM EFFICIENCY INVERTER DUTY MOTOR WITH AEGIS GROUNDING RING.

NO. 530 IU-2 530

REMARKS: (1) WALL MOUNTED INDOOR EVAPORATOR UNIT. (2) MOUNT INDOOR UNIT 7'-6" AFF TO BOTTOM UNIT.

67.0 MMDB024S4-2P

(3) PROVIDE WITH WALL MOUNTED WIRED CONTROLLER.

POWER & CONTROL WIRING TO INDOOR UNIT SHALL BE

INDOOR UNIT

WB(°F)

67.0

67.0

SELECTION

BASED ON

"LENNOX"

MWMA018S4-2P

MWMA018S4-2P

MWMA024S4-2P

ELECTRICAL

RLA

0.13

0.13

0.30

MARK

CAPACITY

COOLING

17.0

17.0

HEATING

(MBH)

18.0

18.0

CONDITIONS. PROVIDE WITH LOW AMBIENT CONTROLS FOR OPERATION

CFM

400

(2) PROVIDE WITH HANGER BRACKETS AND FITTINGS.

SPLIT SYSTEM HEAT PUMP AIR CONDITIONING UNIT SCHEDULE

DB(°F)

95.0

95.0

95.0

95.0

NO.

OU-1

OU-1

OU-2

OU-4

(MBH)

8.5

(6) PROVIDE WITH CONDENSATE PUMP, "REACTOR SEAL" MINI AQUA MODEL 83809 OR EQUAL.

WB(°F)

78.0

SERVED FROM OUTDOOR UNIT. WIRING BETWEEN UNITS BY (7) PROVIDE INDOOR UNIT WITH 14/3 CONDUCTOR AND 3-POLE DIV 23 IN ACCORDANCE WITH THE REQUIREMENTS OF DIV 26. DISCONNECT SWITCH.

GRILLE, REGISTER & DIFFUSER SCHEDULE

MARK	NECK SIZE	DESCRIPTION	MATERIAL	FINISH	VOLUME DAMPER	SHAPE	MAXIMUM △P	MAXIMUM NC	SELECTION BASED ON "PRICE"	REMARKS
A	6"ø	LOUVERED FACE ADJUSTABLE CEILING DIFFUSER	STEEL	WHITE	NO	SQUARE	0.1"	25	SCDA	1 2
B	8"ø	LOUVERED FACE ADJUSTABLE CEILING DIFFUSER	STEEL	WHITE	NO	SQUARE	0.1"	25	SCDA	1 2
(C)	10"ø	LOUVERED FACE ADJUSTABLE CEILING DIFFUSER	STEEL	WHITE	NO	SQUARE	0.1"	25	SCDA	1 3
D	12"ø	LOUVERED FACE ADJUSTABLE CEILING DIFFUSER	STEEL	WHITE	NO	SQUARE	0.1"	25	SCDA	1 3
E	6"x5"	DUCT MOUNTED SUPPLY GRILLE, DOUBLE DEFLECTION	STEEL	WHITE	NO	RECTANGULAR	0.1"	25	520	4
F	10"x8"	DUCT MOUNTED SUPPLY GRILLE, DOUBLE DEFLECTION	STEEL	WHITE	NO	RECTANGULAR	0.1"	25	520	4
G	12"ø	CONCENTRIC RING NOZZLE DIFFUSER	STEEL	WHITE	NO	ROUND	0.1"	35	AND	1
H	12"x8"	DUCT MOUNTED SUPPLY GRILLE, DOUBLE DEFLECTION	STEEL	WHITE	NO	RECTANGULAR	0.1"	25	520	4
	14"x12"	DUCT MOUNTED SUPPLY GRILLE, DOUBLE DEFLECTION	STEEL	WHITE	NO	RECTANGULAR	0.1"	25	520	4)
J	34"x8"	DUCT MOUNTED SUPPLY GRILLE, DOUBLE DEFLECTION	STEEL	WHITE	NO	RECTANGULAR	0.1"	25	520	4)
T	72"X14"	CEILING RETURN OR EXHAUST GRILLE 45° DEFLECTION, 3/4" SPACING	STEEL	WHITE	NO	RECTANGULAR	0.1"	25	530	5
U	14"X12"	CEILING RETURN OR EXHAUST GRILLE 45° DEFLECTION, 3/4" SPACING	STEEL	WHITE	NO	RECTANGULAR	0.1"	25	530	4
V	10" x 10"	CEILING RETURN OR EXHAUST GRILLE 45° DEFLECTION, 3/4" SPACING	STEEL	WHITE	NO	SQUARE	0.1"	25	530	4
W	22" x 22"	CEILING RETURN OR EXHAUST GRILLE 45° DEFLECTION, 3/4" SPACING	STEEL	WHITE	NO	SQUARE	0.1"	25	530	1)
X	18" x 18"	CEILING RETURN OR EXHAUST GRILLE 45° DEFLECTION, 3/4" SPACING	STEEL	WHITE	NO	SQUARE	0.1"	25	530	1)
Y	12" x 12"	CEILING RETURN OR EXHAUST GRILLE 45° DEFLECTION, 3/4" SPACING	STEEL	WHITE	NO	SQUARE	0.1"	25	530	1)
Z	8" x 8"	CEILING RETURN OR EXHAUST GRILLE 45° DEFLECTION, 3/4" SPACING	STEEL	WHITE	NO	SQUARE	0.1"	25	530	1

REMARKS: 1

REFER TO ARCHITECT'S REFLECTED CEILING PLAN FOR CEILING TYPES. FOR ACOUSTIC CEILING, PROVIDE WITH 24" x 24" PANEL SUITABLE FOR MOUNTING IN LAY-IN GRID. FOR DRYWALL CEILING, PROVIDE WITH SMALL FACE AND SURFACE MOUNT FRAME.

PROVIDE 3-CONE, 12" x 12" FACE MOUNTED IN 2' x 2' METAL PANEL.

PROVIDE 4-CONE, 24" x 24" FACE MOUNTED IN 2' x 2' METAL PANEL.

DUCT MOUNTED GRILLE.

GRILLE TO BE MOUNTED IN FACE OF WALL.

ELECTRIC CABINET UNIT HEATER SCHEDULE ELECTRIC HEATING COIL SELECTION BASED MARK CFM REMARKS ON "QMARK" MBH KW V PH AMPS 136 16.4 CUH-1 23.1 CWH3508F 4.8 208 136 23.1 CWH3508F CUH-2 100 16.4 4.8 208 136 23.1 CWH3508F CUH-3 100 16.4 4.8 208 2 4 5 CUH-4 150 13.7 4.0 208 19.2 EFF4008 2 4 5 19.2 EFF4008 CUH-5 150 13.7 4.0 208 136 23.1 CWH3508F CUH-6 100 16.4 4.8 208 136 CUH-7 100 | 16.4 | 4.8 | 208 23.1 CWH3508F

REMARKS: (1) VERTICAL SURFACE MOUNTED UNIT CONFIGURATION.

(2) HORIZONTAL RECESSED UNIT CONFIGURATION.

(3) THERMOSTAT PROVIDED BY AUTOMATIC TEMPERATURE CONTROLS CONTRACTOR.

(4) PROVIDE WITH INTEGRAL THERMOSTAT AND FACTORY WIRED DISCONNECT SWITCH.

(5) PROVIDE WITH DISCONNECT SWITCH AND FAN SPEED SWITCH.

(6) INSTALL APPROXIMATELY 6" AFF MEASURED TO THE BOTTOM OF THE UNIT.

HEAT TRACE SCHEDULE										
EQUIPMENT SERVED	EMERGENCY POWERED	SINGLE OR DOUBLE TRACED	NO. OF CIRCUITS PER PIPE	WATTS/LF	V	PHASE	ESTIMATED LENGTH (LF)	MAXIMUM LENGTH (LF)	METHOD OF CONTROL	REMARKS
							` '	, ,		
C-1 SUPPLY	YES	SINGLE	1	8	120	1	50	390	THERMOSTAT CONTROLLER	1245
C-1 RETURN	YES	SINGLE	1	8	120	1	50	390	THERMOSTAT CONTROLLER	1245
CHILLER BLOCK HEATER	YES	-	-	-	-	-	-	-	FIELD CONTROLLER	3
FIRE SPRINKLER PIPING	-	-	-	-	1	-	-	-	-	6

REMARKS: (1) REFER TO SPECIFICATION 230500 FOR ADDITIONAL REQUIREMENTS.

(2) FIELD VERIFY TOTAL LENGTH OF HEAT TRACE REQUIRED. PROVIDE PLANNED OR AS-BUILT PIPING ROUTE TO HEAT TRACE CABLE MANUFACTURER TO DETERMINE THE LENGTH REQUIRED. THE CONTRACTOR IS RESPONSIBLE FOR PROVIDING A SECOND CIRCUIT AND CONTROLLER IF THE HEAT

(3) REFER TO CHILLER'S MANUFACTURER'S REQUIREMENTS FOR EQUIPMENT BLOCK HEATER.

TRACE CABLE MUST EXCEED THE CIRCUIT MAXIMUM.

SLS

BID DOCUMENTS

10/3/2023

MECHANICAL

SCHEDULES

1 10/18/2023 ADDENDUM 001

PROJECT MANAGER:

QEA No.42240940

RHC

PUBLIC SCHOOLS

ELEMENTARY SCHOOL

RICHMOND PUBLIC SCHOOLS

2300 HANOVER AVENUE RICHMOND, VA 23220

v 804.788.4774 QUINNEVANS.COM

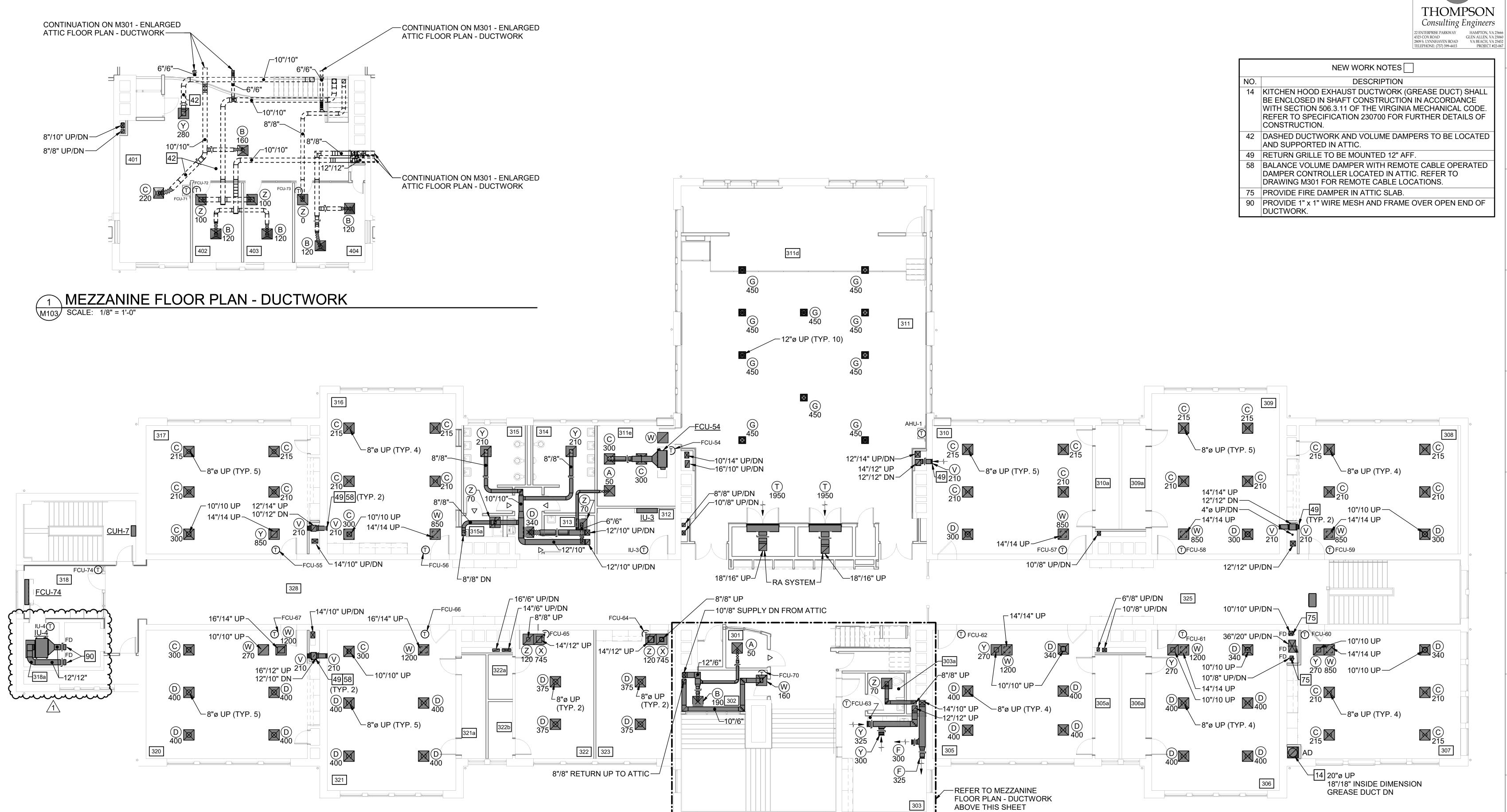
WILLIAM FOX RECONSTRUCTION

1 10/18/2023 ADDENDUM 001

QEA No.42240940

BID DOCUMENTS 10/3/2023

DUCTWORK



LEVEL 3 FLOOR PLAN - DUCTWORK

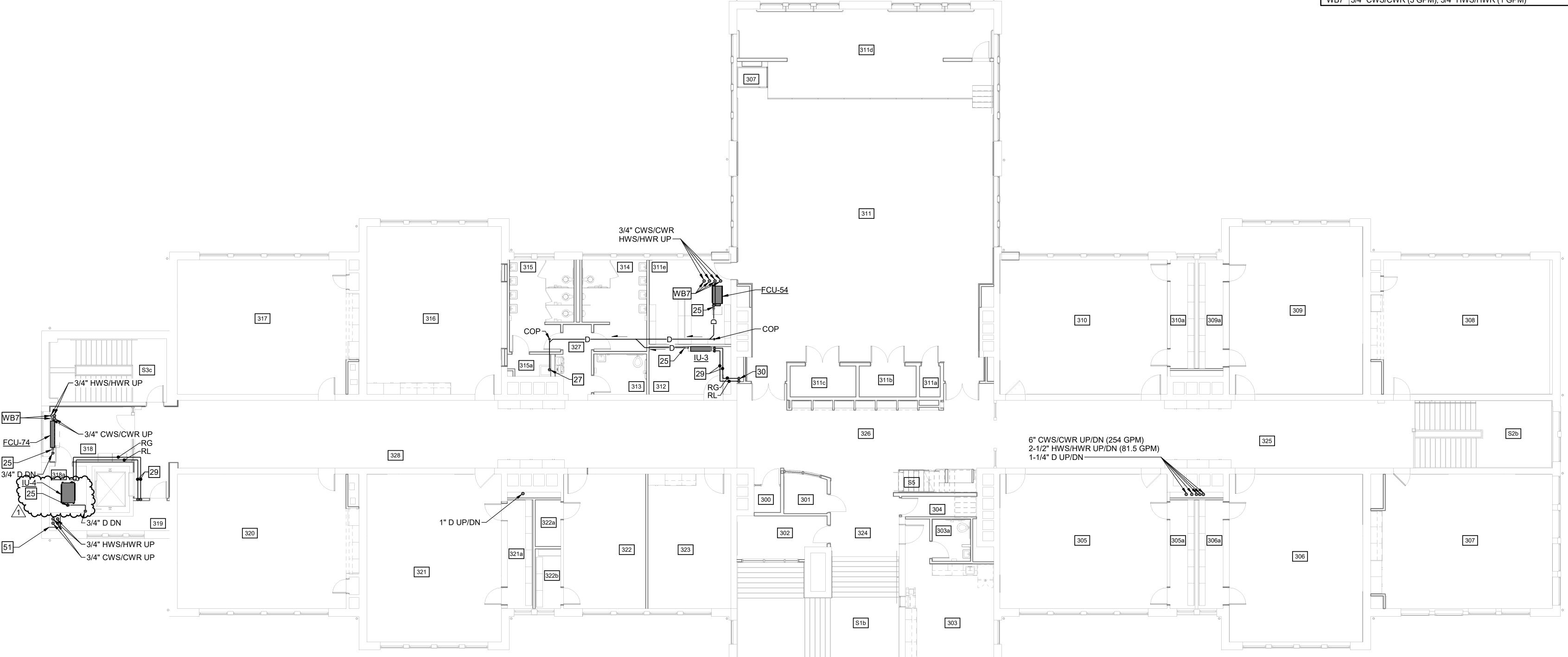
SCALE: 1/8" = 1'-0"

LEVEL 3 FLOOR PLAN -



NEW WORK NOTES

- NO. DESCRIPTION
 25 REFER TO POSITIVE PRESSURE COIL CONDENSATE TRAP
- DETAIL ON DRAWING M402.
- DISCHARGE CONDENSATE DRAIN TO MOP SINK.
 RL, RG PIPING. SIZE IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.
- 30 REFRIGERANT PIPING FROM BELOW.
- PROVIDE PAINTED METAL PIPE COVERS TO CONCEAL ALL PIPING. PAINT COVERS TO MATCH FCU COLOR. REFER TO DRAWING M404 FOR DETAILS.
- WB7 3/4" CWS/CWR (3 GPM), 3/4" HWS/HWR (1 GPM)



LEVEL 3 FLOOR PLAN - PIPING

SCALE: 1/8" = 1'-0"

QUNN EVANS

1840 WEST BROAD STREET SUITE 400 RICHMOND, VA 23220

QUINNEVANS.COM

v 804.788.4774





WILLIAM FOX ELEMENTARY SCHOOL RECONSTRUCTION

RICHMOND PUBLIC SCHOOLS

2300 HANOVER AVENUE RICHMOND, VA 23220

1 10/18/2023 ADDENDUM 001

No. Date Description

PROJECT MANAGER: DRAWN BY

QEA No.42240940

BID DOCUMENTS 10/3/2023

LEVEL 3 FLOOR PLAN -PIPING

M203





1840 WEST BROAD STREET SUITE 400 RICHMOND, VA 23220

v 804.788.4774

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KEVIN D. ALLEN Lic. No. 023349 10/3/2023

PUBLIC SCHOOLS **WILLIAM FOX**

ELEMENTARY SCHOOL RECONSTRUCTION RICHMOND PUBLIC

SCHOOLS 2300 HANOVER AVENUE RICHMOND, VA 23220

NEW WORK NOTES DESCRIPTION REFER TO ARCHITECTURAL DRAWINGS FOR CHIMNEY PENETRATION DETAIL FOR EXHAUST DUCT. TERMINATE WITH

WIRE MESH SCREEN. 2 OUTSIDE AIR ROUTED UP TO DOGHOUSE AND CONNECTED TO OUTSIDE AIR PLENUM, SIZED TO DOGHOUSE LOUVERS. 3'-0" DEEP. REFER TO A501 FOR LOUVER AND DOGHOUSE DETAILS. 6 FAN COIL UNIT TO BE MOUNTED CONCEALED WITHIN PLENUM RATED SOFFIT.

13 EXHAUST PLENUM. SIZE EQUALS LOUVER WITH HEIGHT OF 2'6" AND 3'-0" DEPTH.

25 REFER TO POSITIVE PRESSURE COIL CONDENSATE TRAP DETAIL ON DRAWING M402.

WHITE PVC PIPE JACKET ON EXTERIOR OF INSULATION. 55 KITCHEN EXHAUST FAN SUPPLIED BY THE KITCHEN EQUIPMENT CONTRACTOR AND INSTALLED BY THE MECHANICAL CONTRACTOR IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS. REFER TO FOOD SERVICE DRAWINGS FOR FURTHER DETAILS.

57 COORDINATE DUCTWORK WITH WOOD TRUSS SHOP DRAWINGS TO ROUTE DUCTWORK THROUGH TRUSS SPACE. 76 TERMINATE GREASE DUCT A MINIMUM OF 40" ABOVE ROOF SURFACE PER VMC 506.3.13.1. REFER TO ARCHITECTURAL DRAWINGS FOR FLASHING DETAILS.

83 UNIT BASE RAIL ON TOP OF I-BEAM.

MANUFACTURER'S INSTRUCTIONS. SUPPORT GREASE DUCT ABOVE ROOF LINE PER MANUFACTURER'S INSTRUCTIONS.

6 FCU-2 50 HYDRONIC PIPING TO BE ROUTED EXPOSED. PROVIDE WITH 2 1/2" CWS/CWR 1 1/4" HWS/HWR-124 |-----|= = = = = = = —LEVEL 1 FLOOR

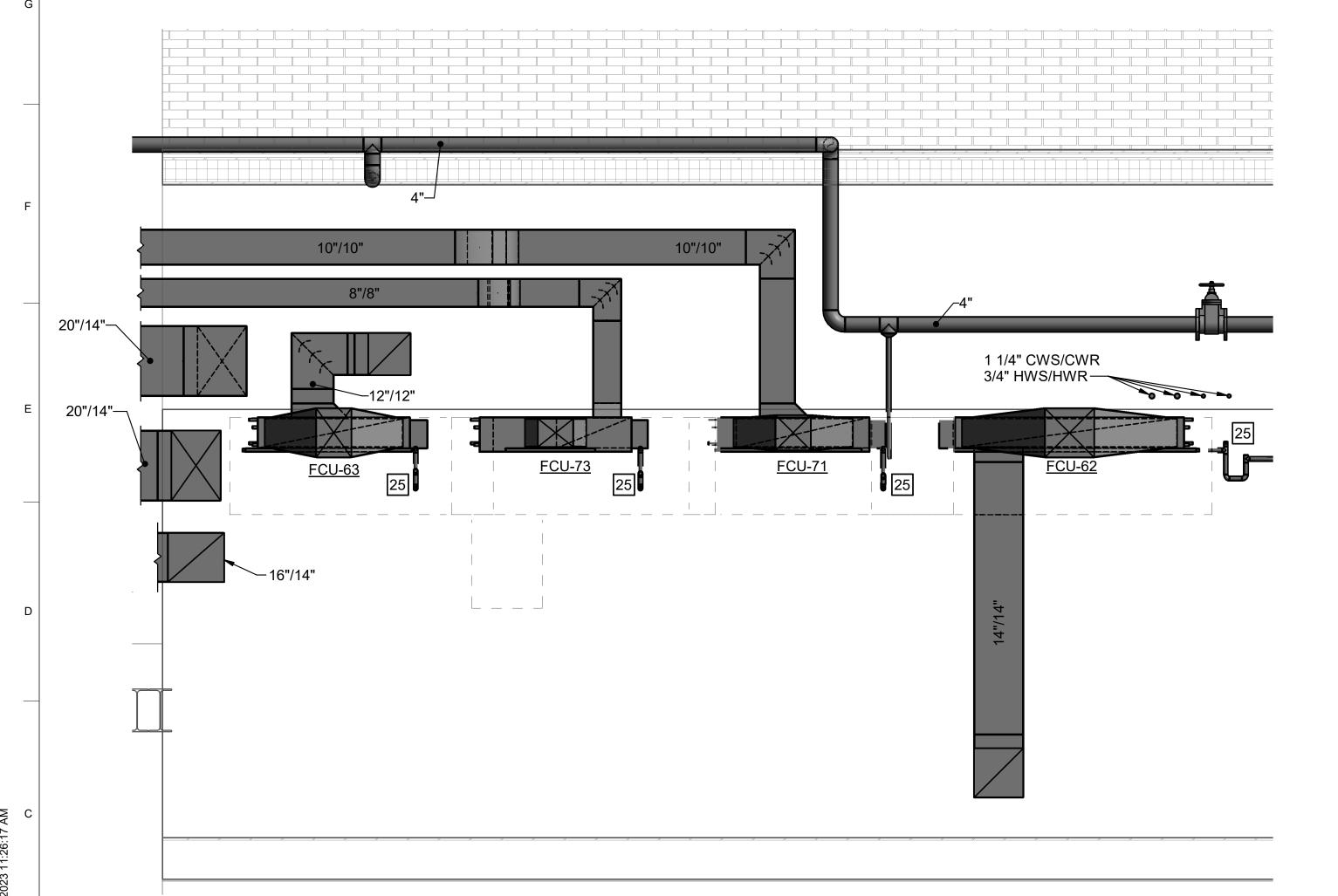
LEVEL 2 FLOOR

G SECTION G M301 SCALE: 1/2" = 1'-0"

(LOOKING PLAN EAST)

←CHIMNEY -CHIMNEY 20"/18" — 24"/22" √4" CWS/CWR 1 1/4" HWR/HWS _ATTIC FLOOR

F SECTION F M301 SCALE: 1/4" = 1'-0" (LOOKING PLAN EAST)



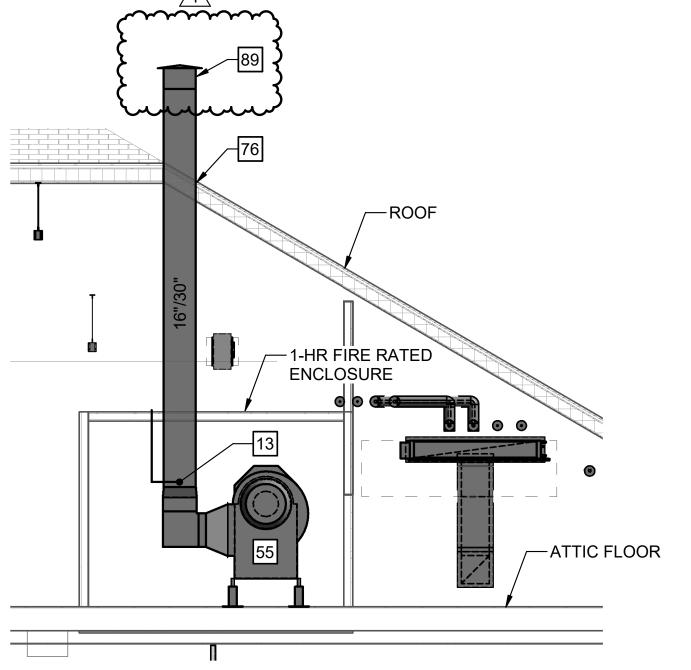
(LOOKING PLAN EAST)

[™]3" CWS/CWR

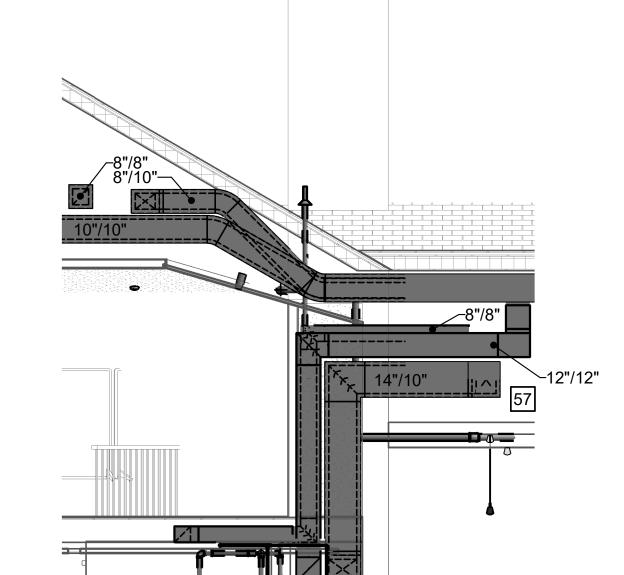
__ATTIC FLOOR

1 1/4" HWS/HWR

(LOOKING PLAN NORTH)



| SECTION | | SCALE: 1/4" = 1'-0" (LOOKING PLAN NORTH)



SECTION JSCALE: 1/4" = 1'-0"

H SECTION H M301 SCALE: 1/2" = 1'-0"

DOG HOUSE-

DOAS-2

E SECTION E

M301 SCALE: 1/4" = 1'-0"

QEA No.42240940 BID DOCUMENTS 10/3/2023

1 10/18/2023 ADDENDUM 001

MECHANICAL SECTIONS

M304

SLS

SECTION 230500 HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and Section 230100 "Mechanical General Provisions" apply to this Section.
- B. Refer to Specification Sections 230900 "Automatic Temperature Controls" and the Control Diagrams on drawings for additional requirements and coordination between equipment and controls.

1.02 WARRANTY-GUARANTEE

A. Contractor shall furnish written warranty, countersigned and guaranteed by the General Contractor, stating that work executed under this Section of the Specifications shall be free from defects of material and workmanship for a period of 12 months from date of Substantial Completion of the building. Refer to Section 230100 for additional warranty period responsibilities.

1.03 SUBMITTALS

- A. Prior to fabrication of any ductwork, Mechanical Contractor shall prepare and submit for review and approval 1/4" scale ductwork shop drawings. Drawings shall indicate all equipment locations and double line ductwork layout. Drawings shall be coordinated with existing conditions and Architectural, Structural, Sprinkler and Electrical Drawings.
- B. Submit manufacturer's performance data and unit details on all products specified below or indicated on drawings.

1.04 PROTECTION OF EQUIPMENT AND MATERIAL

- A. All equipment and material not specifically designed for exterior installation shall not be delivered to the job site until an indoor, dry location is available for storage. All equipment and material shall be covered and protected from dirt, debris, moisture, paint, coatings and damage of any kind. Store off the floor, in a location approved by the Owner, to prevent contact with water.
- B. All air-conveying equipment and material, including but not limited to fan coil units, air handling units, diffusers and ductwork shall be kept clean as described above and all airside surfaces shall be wiped clean (metal surfaces) prior to installation. Where equipment surfaces are subject to additional accumulation of dirt and debris, interior cleaning shall be done after the completion of ductwork installation at all unit openings.
 - 1. Exterior surfaces of all equipment shall be cleaned at completion of construction in a manner that condition and appearance of equipment is the same as it left the factory.
 - 2. No equipment shall be run without approval by the Engineer. Prior to granting approval, the Engineer will require the building to be broom swept clean without air bourn dust which can be pulled into the duct system. An individual area of the building may be partitioned off for temporary use of the HVAC system provided a partition is erected to separate it from the dirty areas and the air handler is adjusted to positively pressurize the conditioned area. The Contractor shall provide temporary filters for all intakes and return connections to air-conveying equipment at his own expense during the construction process in accordance with Specification Section 230100. Generally, a 2-inch MERV 8 temporary filter shall be placed over the return opening followed by two layers of blue construction filter media. The outer layer of blue media shall be changed weekly or sooner if the media is no longer blue. At all times the filter media must be monitored for breakthrough. Maintain a filter log to record all inspections and changes. Filters shall be changed every 14 days regardless of condition. The Contractor assumes full

responsibility for cleanliness of all equipment operated during the construction period and any ductwork used to convey air during construction prior to meeting Substantial Completion. If dust migrates into the duct system, it must be professionally cleaned. The Contractor shall clean all equipment to like-new condition as it appeared when it left the factory prior to substantial completion. All damages shall be repaired/replaced at the Contractor's expense.

3. Operation of the HVAC system during construction requires the safeties and duct smoke detectors to be operational to protect the building and personnel.

PART 2 - PRODUCTS

2.01 HEAT GENERATION

A. Boiler:

 Contractor shall furnish and install natural gas fired, full condensing boilers in accordance with the following specifications and capacities as shown on the plans. Basis of Design is by FULTON HEATING SOLUTIONS, INC., Model Endura EDR. Alternates are CLEAVER-BROOKS "CLEARFIRE", LOCHINVAR "CREST", MESTEK – RBI "FLEXCORE" or approved equal.

2. Boiler Construction:

- a. The boiler shall be completely factory assembled as a self-contained unit. Each boiler shall be neatly finished, thoroughly tested, and properly packaged for shipping.
- The pressure vessel design and construction shall be in accordance with Section IV of the ASME Code for heating boilers. The boiler shall comply with CSD-1 code requirements.
- c. The pressure vessel shell shall be a minimum 5/16" thick steel, SA-790 or SA-516 Grade 70 plate.
- d. Tube sheets should be designed with low weld intensity with a tube to tube minimum spacing of 2" center to center and minimum 5/8" tube to tube ligament.
- e. The firetube area of the heat exchanger where the flue gases will condense shall be constructed using duplex alloys of stainless steel.
- f. Heat exchange capability shall be maximized within the pressure vessel via the use of corrugator fire tube technology. All heat transfer enhancements shall be stainless steel.
- g. The boiler shall be a fire tube design. The furnace location shall be such that all furnace components are within water-backed areas.
- h. The water volume of the boiler shall not be less than:
 - 1) EDR-2000 102 Gallons
- i. If boiler(s) having a lower water volume are supplied, the boiler manufacturer shall include a buffer tank and all associated equipment to make equivalent to the total volume of the Endura boiler(s).

3. Boiler Design:

- a. The boiler shall have its efficiency witnessed and certified by an independent third party, and the efficiency must be listed on the AHRI directory for natural gas operation. The test parameters for efficiency certification shall be the BTS-2000 standard, with 80°F return water temperature, 180°F supply water temperature, steady state operation at full input firing capacity.
- b. The boiler shall have no minimum return water temperature requirements.
- c. A zero flow or low flow condition shall not cause any harm to the pressure vessel or heat exchanger of the boiler. Flow switches, dedicated circulator pumps, or

primary/secondary piping arrangements are not required to protect the heat exchanger or pressure vessel from thermal shock or other system related considerations.

Controls:

- a. The boiler control panel shall be constructed in a UL 508A approved panel shop.
- b. Ignition shall be via direct spark. A UV scanner shall be utilized to ensure precise communication of flame status back to the flame programmer. Flame rods are not acceptable.
- c. The boiler shall operate at no greater O2% than 7.0% over the entire turndown range in order to maximize seasonal efficiency. Boilers exceeding 7.0% O2 at any operating conditions will not be accepted. Boiler firing rate turndown ratio capabilities shall be 5:1.
- d. The boiler shall maintain <20ppm NOx at all operating conditions.
- e. For an individual boiler, the integrated control shall provide boiler status, configuration, history and diagnostics:
 - 1) Flame programming/flame safeguard control
 - Temperature (PID) load control capability for up to two loops (central heat and/or domestic hot water).
 - Color touch screen display with screen saver, screen disable for cleaning, contrast control and volume control for alarm features
 - 4) ModBus communication capabilities
 - a) BACnet communication available with a gateway
 - 5) Time of day display
 - 6) Enable/disable control of up to three (3) devices (pumps, valves, etc.) with programmable time delay for disable of the device(s)
 - 7) Customizable boiler name display
 - Display fifteen (15) most recent alarms including equipment status at time of lockout
 - 9) Ability to accept a remote 4-20mA signal for setpoint or firing rate
 - 10) Password protect options
 - Outdoor reset capabilities for an individual boiler with warm weather shutdown
- f. Each individual boiler shall be able to be set up appropriately with programmable limits displayed on the boiler touchscreen interface:
 - 1) Outlet water temperature:
 - Parameters within the control will be used to manage boiler operating temperatures and turndown to adhere with published manufacturer guidelines.
 - Exhaust/stack temperature
 - Inlet water temperature
 - 4) Outdoor/ambient air temperature
- g. The control can be optionally configured to perform sequencing functions for up to eight (8) boilers installed in the same hydronic loop. Sequencing functionality shall be integral to the boiler control and thus does not require an external control panel.

- General configuration of the boiler control for integrated sequencing capabilities:
 - a) One (1) boiler in the system must be factory programmed as the MASTER and subsequent boilers will be programmed as lag units.
 - i. If at any point the MASTER boiler is taken out of the hydronic system, lag boilers will default to local control.
- 2) The boilers will communicate with each other via a ModBus network (twisted pair, daisy chain).
- 3) Building Management System through interfacing shall be accomplished through the MASTER boiler.
 - a) Modbus protocol will be standard. BACnet MSTP and IP protocol options shall be available.
 - b) Lag boilers shall not require a dedicated gateway for the Building Management System to monitor status.
 - c) The Building Management System will only be required to communicate through the MASTER boiler.
 - d) A communication point mapping list shall be provided.
- h. Outdoor reset controls for multiple boiler systems using the integrated control:
 - 1) The following sensors shall be provided:
 - a) Outdoor air/ambient temperature sensor and module.
 - b) Hydronic supply water temperature sensor and well.
 - The MASTER boiler shall be field programmed with the customer's desired outdoor reset schedule.
 - 3) The MASTER boiler shall have the ability to disable the entire hydronic boiler system based on a programmable outdoor air temperature (warm weather shutdown).
- i. Sequencing logic of multiple boilers using the capabilities of the integrated control:
 - 1) Boilers will be rotated based on a sequenced order and a programmable number of run hours.
 - 2) Boilers will be enabled/disabled at a programmable minimum firing rate and modulated in parallel to meet load requirements. For example in a two boiler system:
 - upon call for heat in the system, the first boiler will be enabled and will modulate to the programmed minimum firing rate, for example 20%. This value is adjustable in the field.
 - b) If the heating load is not satisfied, the second boiler will be enabled also at 20%.
 - c) Both boilers will modulate up and down in parallel with infinite modulation points to meet heating load requirements.
 - d) As the load decreases, the boilers will be sequentially disabled.
 - 3) Each individual boiler can enable/disable up to three (3) devices. The enable of each device, for example a pump or motorized isolation valve, will be simultaneous with the heat demand for that boiler. The disable of each device will be based on a programmable time delay when the heat demand is no longer present.
- i. Burner selection:

- 1) The burner shall be a premix low emission design with a build in flame arrestor functionality.
- k. The burner shall feature direct spark ignition. Pilot assemblies are not accepted.
- I. Boiler safety controls shall include:
 - 1) Operating Temperature Limit for automatic start and stop.
 - 2) High Temperature Limit with manual reset.
 - 3) Low Water Safety Relay monitoring a probe in the boiler pressure vessel.
 - 4) Air Safety Switch to prevent operation unless sufficient combustion air is proven.
 - 5) Flame detector to prove combustion.
- m. All controls are to be burner or panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls. All controls shall be mounted and wired according to UL requirements. Electrical power supplied shall be 120/60/1.

5. Main Fuel Train Components:

- A factory mounted main fuel train shall be supplied. The fuel train shall be fully assembled, wired, and installed on the boiler and shall comply with CSD-1 code. The fuel train components shall be enclosed within the boiler cabinet.
- b. A lock up regulator upstream of the fuel train shall be furnished by the boiler manufacturer as a standard component integral to the boiler cabinet. Factory test fire of the boiler with the provided lock up regulator is required.
- Standard CSD-1 fuel train shall comply with IRI, which has been replaced by GE GAP.

6. Boiler Fittings and Trim:

- a. The boiler shall be supplied with an ASME Section IV safety relief valve. The safety relief valve size shall be in accordance with ASME code requirements.
- b. The boiler shall be supplied with a combination temperature and pressure gauge to be mounted on the water outlet piping of the boiler.
- c. A condensate drain connection shall be available on the boiler, allowing flue gas condensate to freely drain out of the exhaust manifold of the boiler. A condensate drain trap assembly shall accompany the boiler system, with pH neutralization accommodations.
 - 1) Condensate drain piping must be galvanized or stainless steel.
- d. The water supply and return connections on the boiler shall be 4" diameter 150# flanged connections. The water connections shall not be designed to support any external structural load from the piping system.
- e. The boiler shall come with lifting eyes and fork truck accessibility for rigging.
- f. Instructions for installation, operation and maintenance of the boiler shall be contained in a manual provided with each boiler.
- g. A wiring diagram corresponding to the boiler configuration shall be included with each boiler.
- h. Each boiler shall be installed and operated in a functioning hydronic system, inclusive of venting, as part of the manufacturing process. A factory test fire report corresponding to the boiler configuration shall be included with each boiler.

7. Installation:

- a. The boiler shall be CSA approved as a direct vent boiler. Vent piping shall be installed in accordance with applicable national and local codes and per the boiler manufacturer's recommendations.
- b. The boiler shall have the outside combustion air intake supply ducted with PVC pipe, or approved equivalent pipe.

8. Warranty:

- a. The pressure vessel shall carry a 10-year warranty against material and workmanship defects.
- The combustor and exhaust pipes (heat exchanger) shall be guaranteed against flue gas corrosion for a period of 10 years on carbon steel boilers or duplex alloy steel boilers.

2.02 REFRIGERATION

- A. Air Cooled Screw Liquid Chiller (C-1):
 - The Contractor shall furnish and install an air-cooled screw compressor water chiller as shown and scheduled on the drawings. The unit shall be installed in accordance with this Specification and produce the specified tonnage per the scheduled data in accordance with ARI 550-90. The unit shall bear the ARI certification label as applicable.
 - a. The Basis of Design is DAIKIN APPLIED. Acceptable manufacturers are also:
 - 1) TRANE, YORK or equal.
 - b. The Mechanical Contractor shall be responsible for coordinating with all affected Subcontractors to insure proper provisions for installation of the furnished unit. This coordination shall include, but not be limited to, the following:
 - 1) Reinforced concrete pads.
 - 2) Piping size and connection/header locations.
 - 3) Electrical power requirements and wire/conduit and overcurrent protection sizes.
 - 4) Chiller physical size on plant layout.
 - c. The Mechanical Contractor shall be responsible for all costs incurred by the Subcontractors, and Consultants to modify the building provisions to accept the furnished equipment.

2. General Requirements:

- a. Scope: Provide Microprocessor controlled, twin screw compressor, air cooled, liquid chillers of the scheduled capacities as shown and indicated on the Drawings, including but not limited to:
 - 1) Chiller package
 - 2) Charge of refrigerant and oil
 - 3) Electrical power and control connections
 - 4) Chilled fluid connections
 - 5) Manufacturer start-up
 - 6) Variable Frequency Drive for compressors
- b. Quality Assurance:
 - Products shall be Designed, Tested, Rated and Certi-fied in accordance with, and Installed in compliance with applicable sections of the following Standards and Codes:
 - a) AHRI 550/590 Water Chilling Packages Using the Vapor Compression Cycle

- b) AHRI 370 Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
- c) ANSI/ASHRAE 15 Safety Code for Mechanical Refrigeration
- d) ANSI/ASHRAE 34 Number Designation and Safety Classification of Refrigerants
- e) ASHRAE 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings
- f) ANSI/NFPA 70 National Electrical Code (N.E.C.)
- g) ASME Boiler and Pressure Vessel Code, Section VIII, Division 1
- h) OSHA Occupational Safety and Health Act
- i) Manufactured in facility registered to ISO 9001
- j) Conform to Intertek Testing Services for construction of chillers and provide ETL/cETL Listed Mark
- c. Factory Run Test: Chiller shall be pressure tested, evacuated and fully charged with refrigerant and oil, and shall be factory operational run tested with water flowing through the vessel.
- d. Chiller manufacturer shall have a factory trained and supported service organization.
- e. Warranty: The equipment manufacturer and Contractor shall provide a two-year material, labor and refrigerant warranty on all compressors. In addition, the manufacturer shall provide a material, only warranty on all compressors for a period of 5 years total, beginning at the date of start-up of the compressor.

3. Delivery and Handling:

- a. Unit shall be delivered to job site fully assembled with all interconnecting refrigerant piping and internal wiring ready for field installation and charged with refrigerant and oil by the Manufacturer.
- b. Provide protective covering over vulnerable components for unit protection during shipment. Fit nozzles and open ends with plastic enclosures.
- c. Unit shall be stored and handled per Manufacturer's instructions.

4. General:

- a. Description: Furnish, Install, and Commission factory assembled, charged, and operational run tested air-cooled screw compressor chiller as specified herein and shown on the Drawings. Chiller shall include, but is not limited to, a complete system with multiple independent refrigerant circuits, semi hermetic twin screw compressors, shell and tube type evaporator, air-cooled condenser, R513a refrigerant, lubrication system, interconnecting wiring, safety and operating controls including capacity controller, control center, motor starting components, and special features as specified herein or required for safe, automatic operation.
- b. Operating Characteristics:
 - 1) Provide low and high ambient temperature control options as required to ensure unit is capable of operation from 0°F to 125°F (-18°C to 52°C) ambient temperature.
 - Provide capacity control system capable of reducing unit capacity to 10% of full load for 2 compressor units. Compressor shall start in unloaded condition.
- c. Cabinet: Unit panels, structural elements, control boxes and heavy gauge structural base shall be constructed of painted galvanized steel. All exposed

- sheet steel shall be coated with baked on powder paint to meet 500-hour salt spray test in accordance with the ASTM B117 standard.
- d. Shipping: Unit shall ship in one piece and shall require installer to provide only a single evaporator inlet and outlet pipe connection.

5. Compressors:

- a. Compressors: Shall be direct drive, semi hermetic, rotary twin screw type, including: muffler, tempera-ture actuated 'off cycle' heater, rain-tight terminal box, discharge shut off service valve, suction shut-off service valve for each compressor, and precision machined cast iron housing. Design working pressure of entire compressor, suction to discharge, shall be 350 psig (24 barg) or higher. Compressor shall be U.L. recognized.
- b. Compressor Motors: Refrigerant suction-gas cooled accessible hermetic compressor motor, full suction gas flow through 0.006" (0.1524 mm) maximum mesh screen, with inher-ent internal thermal overload protection and external current overload on all three phases.
- c. Balancing Requirements: All rotating parts shall be statically and dynamically balanced.
- d. Lubrication System: External oil separators with no moving parts, 450 psig (31 barg) design working pressure, and ETL listing shall be provided on the chiller. Refrigerant system differential pressure shall provide oil flow through service replaceable, 0.5-micron, full flow, cartridge type oil filter internal to compressor. Filter bypass, less restrictive media, or oil pump not ac-ceptable.
- e. Capacity Control: Compressors shall start at minimum load. Provide Microprocessor control to command compressor capacity to balance compressor capacity with cooling load.

6. Refrigerant Circuits and Components:

- a. Refrigerant: R-513a. Classified as Safety Group A1 according to ASHRAE 34.
- b. Refrigerant circuits shall incorporate all components necessary for the designed operation including: liquid line shut-off valve with charging port, low side pressure relief device, removable core filter-drier and sight glass with moisture indicator.
- c. Chiller manufacturer shall provide an independent circuit for each compressor to provide maximum redundancy during chiller operation.
- d. Discharge lines shall be provided with manual compressor shut-off service valves.

7. Heat Exchangers:

a. Evaporator:

- Evaporator shall be shell and tube, type with 1 pass arrangements to optimize efficiency and refrigerant charge. Tubes shall be high-efficiency, internally and externally enhanced type copper tubes with 0.035" (0.89 mm) minimum wall thickness at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube shall be roller expanded into the tube sheets providing a leak proof seal and be individually replaceable. Independent refrigerant circuits shall be provided per compressor.
- 2) Constructed, tested, and stamped in accordance with applicable sections of ASME pressure vessel code for mini-mum 235 psig (16 barg) refrigerant side design working pressure and 150 psig (10 barg) liquid side design working pressure.

- 3) Water boxes shall be removable to permit tube cleaning and replacement. Water boxes shall include liquid nozzle connections suitable for ANSI/AWWA C-606 couplings, welding, or flanges.
- 4) Provide vent and drain fittings, and thermostatically controlled heaters to protect to -20°F (-28°C) ambient temperature in off cycle. A separate power connection for evaporator heaters is required and shall be provided by the Contractor.

b. Air-Cooled Condenser:

- 1) Condenser coils shall be micro channel type, parallel flow aluminum alloy tubes metallurgically brazed as one piece to enhanced aluminum alloy fins. Tube and fin type condenser coils are an acceptable alternate when tubes are fabricated of copper, aluminum fin. Unit shall include Louvered Panels (Full Unit): Painted steel to match unit panels, over internal components and condenser coils.
- 2) Ultra-Quiet Fans with Variable Speed Drives. All fans shall be powered by VSDs. Fans shall provide vertical air discharge from extended orifices. Fans shall be composed of corrosion resistant aluminum hub and glass-fiber-reinforced polypropylene composite blades molded into a low-noise airfoil section. Fan impeller shall be dynamically balanced for vibration-free operation. Fan guards of heavy gauge, PVC (polyvinyl chloride) coated or galvanized steel.
- 3) Fan Motors: High efficiency, direct drive, 3-phase, insulation class "F", current protected, Totally Enclosed Air-Over (TEAO), with double sealed, permanently-lubricated ball bear-ings. Open Drip Proof (ODP) fan motors will not be acceptable.

8. Insulation:

- a. Material: Closed-cell, flexible, UV protected, thermal insulation complying with ASTM C 534 Type 2 (Sheet) for preformed flexible elastomeric cellular thermal insulation in sheet and tubular form.
- b. Thickness: 3/4" (19mm.)
- c. Thermal conductivity: 0.26 (BTU/HR-Ft2-°F/in) maximum at 75°F mean temperature.
- d. Factory-applied insulation over cold surfaces of liquid chiller components including evaporator shell, water boxes, and suction line. Liquid nozzles shall be insulated by Contractor after pipe installation.
- e. Adhesive: As recommended by insulation manufacturer and applied to 100 percent of insulation contact surface including all seams and joints.

9. Acoustical Data:

- a. Provide with enhanced sound package including but not limited to compressor attenuation and super low sound fans.
- b. Submit acoustical sound power or sound pressure level data in decibels (dB) at the scheduled eight (8) octave band center frequencies. A weighted sound data alone is not acceptable.
- c. Submit all sound power or sound pressure level data at 100%, 75%, 50%, and 25% load.
- d. Acoustical performance ratings shall be in accordance with AHRI Standard 370.
- 10. Power and Electrical Requirements:
 - a. Power/Control Panel:

- Factory installed and wired NEMA 3R, powder painted steel cabi-nets with tool lockable, hinged, latched, and gasket sealed outer doors equipped with wind struts for safer servicing. Provide main power connection(s), compressor starters and fan motor contactors, current overloads, and factory wiring.
- 2) Panel shall include control display access door.

b. Single Point Power:

- 1) Provide single point power connection to chiller, shall be 3-phase of scheduled voltage.
- 2) Single Point disconnect: A unit-mounted disconnect with external lockable handle shall be provided at the point of incoming single point connection for field connection, interconnecting wiring to the compressors, and isolating the power voltage for servicing. Incoming power wiring must comply with local codes.
- c. Control Transformer: Power panel shall be supplied with a factory mounted and wired control transformer that will supply all unit control voltage from the main unit power supply. Transformer shall utilize sched-uled line voltage on the primary side and provide 115V/1Ø on secondary.
- d. Short Circuit Withstand Rating of the chiller electrical enclosure shall be (460V: 65 KAIC.) Rating shall be published in accordance with UL508.
- e. Motor Starters: Motor starters shall be zero electrical inrush current (Variable Frequency Drives) or reduced inrush type (Closed transition Wye-Delta or Solid State) for minimum electrical inrush. Open transition Wye-Delta and Across the Line type starters will not be acceptable.

f. Power Factor:

- 1) Provide equipment with power factor cor-rection capacitors as required to maintain a displacement power factor of 95% at all load conditions.
- 2) The installing contractor is responsible for ad-ditional cost to furnish and install power factor correction capacitors if they are not factory mounted and wired.
- g. All exposed power wiring shall be routed through liquid-tight, UV-stabilized, nonmetallic conduit.
- h. Supplied equipment shall not exceed scheduled Minimum Circuit Ampacity (MCA). The Mechanical Contractor shall be responsible for any additional costs associated with equipment deviation.

11. Controls:

General:

- Provide automatic control of chiller operation including compressor start/stop and load/un-load, anti-recycle timers, condenser fans, evaporator pump, evaporator heater, unit alarm contacts and run signal contacts.
- 2) Chiller shall automatically reset to normal chiller operation after power failure.
- 3) Unit operating software shall be stored in non-volatile memory. Field programmed set points shall be retained in lithium battery backed regulated time clock (RTC) memory for minimum 5 years.
- 4) Alarm contacts shall be provided to remote alert for any unit or system safety fault.
- 5) Provide phase monitor protection.

- b. Display and Keypad:
 - 1) Provide minimum 80-character liquid crystal display that is both viewable in direct sunlight and has LED backlighting for nighttime view-ing. Provide one keypad and display panel per chiller.
 - 2) Display and keypad shall be accessible through display access.
 - 3) Display shall provide a minimum of unit setpoints, status, electrical data, temperature data, pressures, safety lockouts and diagnostics without the use of a coded display.
 - 4) Descriptions in English (or available language options), numeric.
 - 5) Sealed keypad shall include unit On/Off switch.
- c. Programmable Setpoints: Display language, chilled liquid cooling mode, local/remote control mode, display units mode, system lead/lag control mode, remote temperature reset, remote current limit, remote sound limit, low ambient temperature cutout enable/disable, leaving chilled liquid setpoint and range, maximum remote temperature reset.
- d. Display Data: Chilled liquid leaving and entering temperatures; outside ambient air temperature; lead system; evaporator pump status; active remote control; compressor suction, discharge, and oil pressures per refrigerant circuit; compressor discharge, motor, and oil temperatures per refrigerant circuit; saturation temperatures per refrigerant circuit; compressor speed; condenser fan status; condenser sub-cooling temperature; condenser drain valve per-centage open; compressor capacity in percentage of Full Load Amps; compressor number of starts; run time; operating hours; evaporator heater status; history data for last ten shutdown faults; history data for last 20 normal (non-fault) shutdowns.
- e. Predictive Control Points: Unit controls shall avoid safety shutdown when operating outside design con-ditions by optimizing the chiller controls and cooling load output to stay online and avoid safety limits be-ing reached. The system shall monitor the following parameters and maintain the maximum cooling output possible without shutdown of the equipment: motor current, suction pressure, discharge pressure, starter internal ambient temperature, and starter baseplate temperature.
- f. System Safeties: Shall cause individual compressor systems to perform autoreset shut down if: high discharge pressure or temperature, low suction pressure, low motor current, high/low differential oil pressure, low discharge superheat, high motor temperature, system control volt-age.
- g. Unit Safeties: Shall be automatic reset and cause compressors to shut down if: high or low ambient temperature, low leaving chilled liquid temperature, under voltage, flow switch operation. Contractor shall provide flow switch and wiring per chiller manufacturer require-ments.
- h. Manufacturer shall provide any controls not listed above, necessary for automatic chiller operation. Mechanical Contractor shall provide field control wiring necessary to interface sensors to the chiller control system.
- 12. Accessories and Options: Some accessories and options supersede standard product features. All options are factory mounted unless otherwise noted. Provide the following options:
 - a. Controls Options:
 - Gateway: Provides communication for Building Automation Systems, including BACnet (MS/TP), Modbus, N2, and LON. (Field Commissioned by BAS Manufacturer)

b. General Options:

- 1) Differential Pressure Switch: 3-45 psig (0.2-3 barg) range with 1/4" NPTE pressure connections. (Field Mounted by Contractor)
- Vibration Isolation (Field Mounted by Contractor): Provide Elastomeric Isolators
- 3) Low Sound Kit
- 4) Factory service start up
- 5) 2-year parts, labor and refrigerant extended compressor warranty.
- Fully louvered architectural panels completely enclosing all components of the chiller.

13. Installation:

- a. General: Rig and Install in full accordance with Manu-facturer's requirements, Project drawings, and Contract documents.
- b. Location: Locate chiller as indicated on drawings, including cleaning and service maintenance clearance per Manufacturer instructions. Adjust and level chiller on support structure.
- c. Components: Installing Contractor shall provide and install all auxiliary devices and accessories for fully operational chiller.
- d. Electrical: Coordinate electrical requirements and connections for all power feeds with Electrical Contractor.
- e. Controls: Coordinate all control requirements and connections with Controls Contractor.
- f. Finish: Installing Contractor shall paint damaged and abraded factory finish with touchup paint matching factory finish.

14. Verification of Capacity, Efficiency and Operation

- All proposals for chiller performance must include an AHRI approved selection method. Verification of date and version of computer program selection or catalog is available through AHRI.
- b. Each chiller shall be factory performance tested in an ambient controlled, AHRI 550/590 approved test facility. The manufacturer shall supply a certified test report to confirm performance as specified. Proper AHRI certification documents for the test loop shall be made available upon request from the manufacturer for inspection. The performance test shall be conducted in accordance with AHRI Standard 550/590 procedures and tolerances.
- c. The test conditions shall be at AHRI standard rating conditions, 44F leaving evaporator,54F entering evaporator and 95 ambient.
- d. The following allowable tolerances must be referenced:
- e. The tolerance on capacity shall be as defined by AHRI Standard 550/590 for full and part load points.
- f. The tolerance on efficiency shall be defined by AHRI Standard 550/590 for IPLV/NPLV, full load and all part load test points.
- g. The performance test shall be run with clean tubes in accordance with AHRI Standard 550/590 to include the following:
- h. A downward temperature adjustment shall be made to the design leaving evaporator water temperature to adjust from the design fouling to the clean tube condition.

i. The factory test instrumentation shall be per AHRI Standard 550/590, and the calibration of all instrumentation shall be traceable to the National Institute of Standards and Technology (formerly NBS). A certified test report of all data shall be submitted to the Contracting Officer prior to completion of the project. The factory certified test report shall be signed by an officer of the manufacturer's company. Preprinted certification will not be acceptable; certification shall be in the original.

2.03 AIR HANDLING EQUIPMENT

- A. Air Handling Units (DOAS-1, 2, 3 and AHU-1)
 - 1. Contractor shall furnish and install air handling units in accordance with the following specifications and capacities as shown on the plans. Basis of Design is by DAIKIN.. Alternates are TRANE, AAON or approved equal.
 - 2. General Description
 - a. Configuration: Fabricate as detailed on drawings.
 - b. Performance: Conform to AHRI 430. See schedules on prints.
 - c. Acoustics: Sound power levels (dB) for the unit shall not exceed the specified levels shown on the unit schedule. The manufacturer shall provide the necessary sound treatment to meet these levels if required.

3. Unit Construction

- Fabricate unit with heavy gauge channel posts and panels secured with mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket. Shipped loose gasketing is not allowed.
- b. Panels and access doors shall be constructed as a 2-inch nominal thick; thermal broke double wall assembly, injected with foam insulation with an R-value of not less than R-13.
 - 1) The inner liner shall be constructed of G90 galvanized steel.
 - 2) The outer panel shall be constructed of G90 galvanized steel.
 - 3) The floor plate shall be constructed as specified for the inner liner.
 - 4) Unit will be furnished with solid inner liners.
- c. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 5 inches of positive or 6 inches of negative static pressure. Deflection shall be measured at the panel midpoint.
- d. The casing leakage rate shall not exceed 0.50 cfm per square foot of casing surface area at design static pressure up to a maximum of +5" w.c. in positive pressure sections and -6" w.c. in negative pressure sections (.0025 m3/s per square meter of cabinet area at 1.24 kPa static pressure)
- e. Module to module field assembly shall be accomplished with an overlapping, full perimeter internal splice joint that is sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.
- f. Access doors shall be flush mounted to cabinetry, with minimum of two six inch long stainless steel piano-type hinges, latch and full size handle assembly. Access doors shall swing outward for unit sections under negative pressure. Access doors on positive pressure sections, shall have a secondary latch to relieve pressure and prevent injury upon access.
- g. A 6-inch formed G60 galvanized steel base rail shall be provided by the unit manufacturer for structural rigidity and condensate trapping. The base rail shall be constructed with 12-gauge nominal for unit sizes 003 - 035 and 10-gauge nominal for unit sizes 040 - 090. The following calculation shall determine the required

height of the base rail to allow for adequate drainage. Use the largest pressure to determine base rail height. [(Negative)(Positive) static pressure (in)] (2) + 4" = required base rail height. Should the unit base rail not be factory supplied at this height, the contractor is required to supply a concrete housekeeping pad to make up the difference.

h. Construct drain pans from stainless steel with cross break and double sloping pitch to drain connection. Provide drain pans under cooling coil section. Drain connection centerline shall be a minimum of 3" above the base rail to aid in proper condensate trapping. Drain connections that protrude from the base rail are not acceptable. There must be a full 2" thickness of insulation under drain pan.

4. Fan Assemblies

- a. Acceptable fan assembly shall be a single width, single inlet, class II, direct-drive type plenum fan dynamically balanced as an assembly, as shown in schedule. Maximum fan RPM shall be below first critical fan speed. Fan assemblies shall be dynamically balanced by the manufacturer on all three planes. Provide access to motor and fan assembly through hinged access door.
- b. Fan and motor shall be mounted internally on a steel base. Factory mount motor on slide base that can be slid out the side of the unit if removal is required. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly shall be mounted on 2" deflection spring vibration type isolators inside cabinetry.

5. Bearings, Shafts, and Drives

- a. Bearings: Basic load rating computed in accordance with AFBMA ANSI Standards. The bearings shall be provided on the motor with the fan wheel mounted directly on the motor shaft, AMCA arrangement 4.
- b. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.
- c. The fan wheel shall be direct coupled to the motor shaft. The wheel width shall be determined by motor speed and fan performance characteristics.

6. Electrical

- a. Fan motors shall be manufacturer provided and installed, Open Drip Proof, premium efficiency (meets or exceeds EPAct requirements), 1750 RPM, single speed, 230V / 60HZ / 3P. Complete electrical characteristics for each fan motor shall be as shown in schedule.
- b. Fan motors shall be manufacturer provided and installed, Open Drip Proof, premium efficiency (meets or exceeds EPAct requirements), 3500 RPM, single speed, 230V / 60HZ / 3P. Complete electrical characteristics for each fan motor shall be as shown in schedule.
- c. The air handler(s) shall be ETL and ETL-Canada listed by Intertek Testing Services, Inc. Units shall conform to bi-national standard ANSI/UL Standard 1995/CSA Standard C22.2 No. 236.
- d. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclosed terminal lugs in terminal box sized to NFPA 70.
- e. Manufacturer shall provide ASHRAE 90.1 Energy Efficiency equation details for individual equipment to assist Building Engineer for calculating system compliance.
- f. Air handler manufacturer shall provide and mount conduit and wiring from each fan motor terminated at an external junction box.

7. Cooling and Heating Coils

- a. Certification: Acceptable water cooling, water heating, steam, and refrigerant coils shall be certified in accordance with AHRI Standard 410 and bear the AHRI label. Coils exceeding the scope of the manufacturer's certification and/or the range of AHRI's standard rating conditions will be considered provided the manufacturer is a current member of the AHRI Forced Circulation Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with AHRI Standard 410. Manufacturer must be ISO 9002 certified.
- b. Water cooling coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
- c. Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.
- d. Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
- e. Coil tubes shall be 5/8 inch OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins, brazed at joints.
- f. Coil connections shall be carbon steel, NPT threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point to ensure proper venting. Drain connections shall be provided at the lowest point to insure complete drainage and prevent freeze-up.
- g. Coil casing shall be a formed channel frame of galvanized steel.
- h. Water heating coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
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- k. Coil tubes shall be 5/8 inch OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins, brazed at joints.
- I. Coil connections shall be carbon steel, threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point to ensure proper venting. Drain connections shall be provided at the lowest point to insure complete drainage and prevent freeze-up.
- m. Coil shall be furnished as an uncased galvanized steel to allow for thermal movement and slide into a pitched track for fluid drainage.

8. Filters

- a. Furnish flat panel filter section with 2-inch pleated MERV 8 filter. Provide side loading and removal of filters.
- b. Filter media shall be UL 900 listed. Class I or Class II.
- Filter Magnehelic gauge(s) shall be furnished and mounted by equipment manufacturer.

9. Additional Sections

- a. Plenum section shall be provided and properly sized for inlet and/or discharge air flow (between 600 and 1500 feet per minute). The plenum shall provide single or multiple openings as shown on drawings and project schedule.
- b. Access section shall be provided for access between components.
- c. Economizer section shall be provided with end outside air opening and top return air opening and top exhaust air opening without (opening only) or with parallel low leak airfoil damper blades. If furnished with dampers, they shall be hollow core galvanized steel airfoil blades, fully gasketed and have continuous vinyl seals between damper blades in a galvanized steel frame. Dampers shall have stainless steel jamb seals along end of dampers. Linkage and ABS plastic end caps shall be provided when return and outside air dampers sized for full airflow. Return and outside air dampers of different sizes or very large dampers and exhaust dampers must be driven separately. Damper Leakage: Leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. Leakage rate tested in accordance with AMCA Standard 500.

10. Energy Recovery Wheel: DOAS Units Only

a. Energy Recovery Wheel shall be constructed of corrugated synthetic fibrous media, with a desiccant intimately bound and uniformly and permanently dispersed throughout the matrix structure of the media. Rotors with desiccants coated bonded, or synthesized onto the media are not acceptable due to delaminating or erosion of the desiccant material. Media shall be synthetic to provide corrosion resistance and resistance against attack from laboratory chemicals present in pharmaceutical, hospital, etc. environments as well as attack from external outdoor air conditions. Coated aluminum is not acceptable. Face flatness of the wheel shall be maximized in order to minimize wear on inner seal surfaces and to minimize cross leakage. Rotor shall be constructed of alternating layers of flat and corrugated media. Wheel layers should be uniform in construction forming uniform aperture sizes for airflow. Wheel construction shall be fluted or formed honeycomb geometry so as to eliminate internal wheel bypass. Wheel layers that can be separated or spread apart by airflow are unacceptable due to the possibility of

channeling and performance degradation. The minimum acceptable performance shall be as specified in the unit schedule.

- 1) Desiccant Material: The desiccant material shall be a molecular sieve, and specifically a 4A or smaller molecular sieve to minimize cross contamination.
- 2) Wheel Media Support System: The wheel frames shall consist of evenly spaced steel spokes, galvanized steel outer band and rigid center hub. The wheel construction should allow for post fabrication wheel alignment. Wheel Seals: The wheel seals shall be full contact nylon brush seals or equivalent. Seals should be easily adjustable.
- Wheel Cassette: Cassettes shall be fabricated of heavy duty reinforced galvanized steel or welded structural box tubing. Cassettes shall have a built in adjustable purge section minimizing cross contamination of supply air as shown on unit schedule. Bearings shall be inboard, zero maintenance, permanently sealed roller bearings, or alternatively, external flanged or pillow block bearings. Drive systems shall consist of fractional horsepower AC drive motors with multi-link drive belts. Face and bypass dampers shall be furnished as shown on unit schedule and drawings.
- 4) Certification: The wheel shall be AHRI certified by the energy recovery wheel supplier to AHRI Standard 1060 and must bear the AHRI certification stamp. Private independent testing performed "in accordance with" various standards is not a substitute for AHRI certification and shall not be accepted. The wheel shall be listed or recognized by UL or equivalent.

11. Installation

a. Install in accordance with manufacturer's Installation & Maintenance instructions.

12. Environmental Requirements

 Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

2.04 UNITARY EQUIPMENT

- A. Ductless Split System Heat Pump Units (IU-1, 2 and 3, OU-1, 2 and 3):
 - 1. The heat pump system shall be a LENNOX Electric split system with variable speed inverter compressor technology or MITSUBISHI, DAIKIN, or approved equal. The system shall consist of a ceiling cassette indoor section that shall include a four (4) way grill with integral return and be equipped with a wired, wall mounted, remote controller and a matched capacity, horizontal discharge, single phase outdoor unit.
 - 2. Quality Assurance:
 - a. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.
 - b. All wiring shall be in accordance with the National Electrical Code (NEC).
 - c. The units shall be rated in accordance with Air-conditioning, Heating, and Refrigeration Institute's (AHRI) Standard 240 and bear the ARI Certification label.
 - d. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
 - e. A dry air holding charge shall be provided in the indoor section.
 - f. The outdoor unit shall be pre-charged with R-410a refrigerant for 70 feet (20 meters) of refrigerant tubing.
 - g. System efficiency shall meet or exceed 13.6 SEER.

- 3. Delivery, Storage and Handling:
 - a. Unit shall be stored and handles according to the manufacturer's recommendations.
 - b. The wireless controller shall be shipped inside the carton with the indoor unit and able to withstand 105°F storage temperatures and 95% relative humidity without adverse effect.

4. Warranty:

- a. The units shall have a manufacturer's parts and defects warranty for a period one (1) year from date of installation. The compressor shall have a warranty of 6 years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty does not include labor.
- b. Manufacturer shall have over 25 years of continuous experience in the U.S. Market.
- 5. Indoor Unit Cabinet (IU-1, 2 and 3):
 - a. The indoor unit cabinet shall be a space-saving ceiling-recessed cassette type. The cabinet shall be formed from galvanized sheet metal coated with high-density foam insulation.
 - b. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, drain left mechanism, control circuit board, fan, and fan motor. Single branch ducting shall be allowed from cabinet. The cabinet panel shall have provisions for a field installed filtered outside air intake.
 - c. A separate grill assembly shall be attached to the front of the cabinet to provide supply air vanes in four directions and a center mounted return air section. The fourway grill shall be fixed to bottom of cabinet allowing two, three or four-way blow. The grill vane angles shall be individually adjustable from the wired remote controller to customize the airflow pattern for the conditioned space. Grill assembly color shall be Munsell 6.4Y8.9/0.4.
 - d. The unit, in conjunction with the wired, wall-mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and integral refrigerant pipes shall be purged with dry nitrogen and caped before shipment from the factory.
 - e. The indoor fan shall be an assembly with a turbo fan propeller, direct driven by a single motor and shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings. The indoor fan shall consist of five (5) speed settings, Low, Mid1, Mid2, High and Auto. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller setpoint and space temperatures.
- 6. Indoor Unit (IU-1, 2 and 3):
 - a. The indoor unit cabinet shall be wall mounted by means of a factory supplied mounting plate. The cabinet shall be formed from high strength molded plastic with front panel access for filter. Cabinet color shall be white Munsell 0.70 8.59/097.
 - b. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor.
 - c. The unit in conjunction with the wired, wall-mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory.
 - d. Fan: The evaporator fan shall be high performance, double inlet, forward curve, direct drive sirocco fan with a single motor. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall consist of four (4) speeds: Low, M1, M2, and Hi.

7. Vanes:

- a. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow with switches that can be set to provide optimum airflow based on ceiling height and number of outlets used.
- b. The indoor unit vanes shall have 5 fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.
- c. The vanes shall have an auto-wave selectable option in the heating mode that shall randomly cycle the vanes up and down to evenly heat the space.
- d. If specified, the grill shall have an optional I-see® sensor that will measure room temperature variations and adjust the airflow accordingly to evenly condition the space.
- 8. Filter: The return air shall be filtered by means of an easily removable, long life, washable filter.

9. Coil:

- a. The indoor unit coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange.
- b. The heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed with PhosCopper or silver alloy.
- c. The coils shall be pressure tested at the factory.
- d. A condensate pan with drain connections shall be provided under the coil. The unit shall also include a built-in, automatic condensate lift mechanism that will be able to raise drain water 33 inches (84cm) above the condensate pan. The lift mechanism shall be equipped with a positive acting liquid level sensor to shut down the indoor unit if liquid level in the drain pan reaches maximum level.

10. Electrical:

- a. The electrical power of the unit shall be 208/230 volts, 1-phase, 60 hertz.
- b. The system shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts.
- c. The indoor unit shall be provided with A-Control a system allowing the indoor unit to be powered and controlled directly from the outdoor unit using a 14-gauge (AWG) 3-wire connection plus ground providing both primary power and integrated, by-directional, digital control signal without additional connections.
- d. The indoor units shall not have any supplemental or "back-up" electrical heating elements.

11. Control:

- a. The control system shall consist of two (2) microprocessors, one in each indoor and outdoor unit, interconnected by A-Control. This three (3) conductor 14 ga. AWG wire with ground method shall provide power feed and bi-directional digital control transmission between the outdoor and indoor units.
- b. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller display panel.
- c. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and for controlling the operation of the outdoor unit.

- d. The indoor unit shall be connected to a wall mounted wired controller to perform input functions necessary to operate the system. The wired controller shall have a large multi-language DOT liquid crystal display (LCD) presenting contents in eight (8) different languages, including English, French, Chinese, German, Japanese, Spanish, Russian, and Italian.
- e. There shall be a built-in weekly timer with up to eight pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Heat/Auto/Cool/Dry/Fan mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Vane Position selector, a Louver Swing button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C). Temperature changes shall be by increments of 1°F (1°C) with a range of 67°F to 87°F (19°C to 30°C).
- f. The wired controller shall display operating conditions such as set temperature, room temperature, pipe temperatures (i.e. liquid, discharge, indoor and outdoor), compressor operating conditions (including running current, frequency, input voltage, On/Off status and operating time), LEV opening pulses, sub cooling and discharge super heat.
- g. Normal operation of the wired controller shall provide individual system control in which one wired controller and one indoor unit are installed in the same room. Temperature sensing shall be done by a Thermistor mounted in the return air stream of the indoor unit. An alternate temperature sensor shall be located within the wall controller. Selection of the sensor is by switch in the indoor unit. The controller shall have the capability of controlling up to a maximum of sixteen systems at a maximum developed control cable distance of 1,650 feet (500 meters).
- h. The control voltage from the wired controller to the indoor unit shall be a digital +/-24 volts, DC signal. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Up to two wired controllers shall be able to be used to control one unit.
- i. Control system s hall control the continued operation of the air sweep louvers, as well as provide On/Off and mode switching. The controller shall have the capability to provide sequential starting with up to fifty seconds delay.
- j. A two wire (one pair) twisted, stranded, 18 gauge (AWG), jacketed, control cable shall be used to connect the controller to the indoor unit.
- k. Mechanical contractor shall install the Control Damper and provide interlock with indoor unit.

12. Outdoor Unit (OU-1, 2 and 3):

- a. The outdoor unit shall be compatible with PLA type indoor units. The connected indoor unit must be of the same capacity as the outdoor unit.
- b. The outdoor unit shall be equipped with a control board that interfaces with the indoor unit to perform all necessary operation functions.
- c. The outdoor unit shall be capable of operating at 0°F (-18°C) ambient temperature without additional low ambient controls (optional wind baffle may be required).
- d. The outdoor unit shall be able to operate with a maximum height difference of 100 feet between indoor and outdoor units.
- e. The system shall have a maximum refrigerant tubing length of 100 feet for the 18,000 and 65 feet for the 24,000, BTU/h units between indoor and outdoor units without the need for line size changes, traps or additional oil. Models PUZ-A18NHA and PUZ-A24NHA shall be pre-charged for a maximum of 70 feet of refrigerant tubing PUZ-A42NHA for 100 feet.
- f. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit

must be test run at the factory.

- g. Cabinet: The casing shall be constructed from galvanized steel plate, coated with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection and have a Munsell 3Y 7.8/1.1 finish. The fan grill shall be of ABS plastic.
- h. Fan: Models PUZ-A18NHA AND PUZ-A24NHA shall be furnished with fan AC fan motor. The fan motor shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated. The outdoor unit shall have horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front. The fan shall be provided with a raised guard to prevent contact with moving parts.
- i. The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up. The coil shall be protected with an integral metal guard. Refrigerant flow from the condenser shall be controlled by means of linear expansion valve (LEV) metering orifice. The LEV shall be controlled by a microprocessor controlled step motor.
- j. The compressor for models PUZ-A18NHA, PUZ-A24NHA, PUZ-A30NHA and PUZ-A36NHA shall be a DC rotary compressor with Variable Compressor Speed Inverter Technology. The compressor f or model PUY-A42NHA shall be a Frame Compliant Scroll compressor with variable speed inverter drive technology. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which results in vast energy savings. To prevent liquid from accumulating the in the compressor during the off cycle, a minimal amount of current shall be intermittently applied to the compressor motor to maintain sufficient heat. The outdoor unit shall have an accumulator and high-pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

B. Ducted Split System (IU/OU-4):

- 1. Unit shall be size, type, and have capacity indicated LENNOX, MITSUBISHI, DAIKIN, or approved equal. Units shall meet or exceed efficiencies scheduled on the drawings.
- 2. Unit shall be horizontal mounted for ducted application. Unit shall be complete with casing, blower, filter, heat exchanger, reversing valve, controls, and condensate trap and drain assembly.
- 3. Evaporator coil shall be constructed of copper tubes and aluminum fins and shall be internally cleaned and provided with refrigerant holding charge. Coil casing shall be pre-painted steel. Piping connections shall be sweat fittings.
- 4. Fan motor shall be open drip proof with internal overloads.
- Provide 24-volt control transformer with control circuit fuse to protect transformer from overload.
- 6. Provide duct flanges for supply duct connections. Return connections shall be either right or left side as indicated on drawings.
- 7. Provide blower door safety switch to interrupt electrical power at the unit when the panel covering the blower compartment is removed.
- 8. Provide filter rack with 2" MERV 8 disposable filters.
- Blower cabinet shall be insulated.
- 10. Provide auxiliary and main drain pans. Install float switch in main drain pan. Switch shall disable unit upon activation.
- 11. Condensing Unit

- a. Unit shall be size, type, and have capacity indicated. LENNOX, MITSUBISHI, DAIKIN. or approved equal.
- b. Outdoor unit shall be complete with scroll compressor, external service valves, charging port, condenser coil, and condenser fan.
- c. Condenser coil shall be constructed of copper tube and aluminum fins. Fins shall be protected with a decorative grille.
- d. Compressor shall be internally protected against high pressure and temperature. This shall be accomplished by the simultaneous operation of the high-pressure relief valve and a temperature sensor which protect the compressor if undesirable operating conditions occur. Compressor shall be isolated to prevent vibration.
- e. Provide liquid line filter dryer factory installed. Secured reusable service valves shall be provided on both the liquid and suction sweat connections for ease of evacuation and charging.
- f. Condenser fan motor bearings shall be long-life, permanently lubricated requiring no annual servicing.
- g. Cabinet shall be made of pre-treated and powder-coated heavy-gauge steel.
- h. Refer to warranty requirements in Section 230100.

2.05 TERMINAL EQUIPMENT

- A. Horizontal Fan-Coil Units:
 - 1. Unit shall be size, type, and have capacity indicated. Provide fan-coil units manufactured by DAIKIN, TRANE, YORK, or approved equal.
 - 2. Fan Coil Type and Arrangement
 - a. The fan coil shall be furnished as a draw-through cooling coil with a heating coil in preheat/reheat position.
 - General Construction
 - a. The units shall include a chassis, coil(s), fan deck with blower(s)/blower housing and motor(s). Steel parts exposed to moisture shall be galvanized and insulated to prevent condensation. The complete fan assembly shall be easily removable for service and maintenance. A quick-connect motor electric plug shall be provided.
 - b. Hideaway
 - 1) Unit shall be supplied with return plenum complete with filter frame and filter. The plenum shall be fabricated of 18 gauge galvanized steel. The inside plenum surface shall be insulated with 1/2" matt-faced fiberglass insulation. Plenum insulation shall meet minimum K value of 0.24 (BTU-in)/(hr-ft2-F) and rated for maximum air velocity of 5000 fpm. Fiberglass insulation conforms to:
 - a) ASTM C1071 (including C665)
 - b) UL 181 for erosion
 - 25/50 rating for flame spread/smoke developed per ASTM E-84,
 UL 723 and NFPA 90A
 - 4. Supply Fan
 - a. Supply fans shall be a DWDI forward-curved type. Fan assemblies including fan, motor and sheaves shall be dynamically balanced by the manufacturer on all three planes at all bearing supports. Manufacturer must ensure maximum fan RPM is below the first critical speed.
 - b. The complete fan assembly, including motor and main drain pan shall be easily removable.

- c. Units shall be certified in accordance with the Room Fan Coil Unit certification program that is based on ARI Standard 440.
- d. ECM blower motor shall be 3 speeds, single phase with means for proportional field adjustment of each speed.

5. Electrical

a. Motor wires shall include a quick-disconnect motor plug.

6. Cooling And Heating

- a. Cooling Coils
 - 1) Cooling performance shall be as specified on the unit schedule.
 - Water coil fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Seamless copper tubes shall be mechanically expanded into the fins to provide a continuous primary-to-secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins. Coil casing shall be constructed of galvanized steel.
 - Water coils shall be provided with headers of seamless copper tubing with intruded tube holes to permit expansion and contraction without creating undue stress or strain. Coil connections shall be copper sweat connections with connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain connections shall be furnished on the coil connection, external to the cabinet. Vent connections shall be provided at the highest point to ensure proper venting. Drain connections shall be provided at the lowest point.
 - 4) All steel parts exposed to moisture shall be galvanized.
 - 5) Unit shall include a noncorrosive, galvanized main drain pan, positively sloped in every plane and insulated with closed-cell insulation. The drain pan shall be designed to ensure no pooling of condensate water per ASHRAE 62.2.

7. Water Heating Coil

- a. Heating performance shall be as specified on the unit schedule.
- b. Coil fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Seamless copper tubes shall be mechanically expanded into the fins to provide a continuous primary-tosecondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
- c. Coils shall be provided with headers of seamless copper tubing with intruded tube holes to permit expansion and contraction without creating undue stress or strain. Coil connections shall be copper sweat connections with connection size to be determined by manufacturer based upon the most efficient coil circuiting. Drain connections shall be furnished on the coil connection, external to the cabinet. Drain connections shall be provided at the lowest point.
- d. Heating coil shall be installed in the reheat position.
- 8. Filters
 - Filters shall be 2" MERV 11 filter. They shall be concealed from sight and easily removable.
- 9. Controls
 - a. Unit controller shall be supplied by DDC contractor.

b. Refer to specification Section 230900 and the Automatic Temperature Controls diagrams in the drawings for unit controller requirements.

B. Vertical Fan-Coil Units:

- 1. Unit shall be size, type, and have capacity indicated. Provide fan-coil units manufactured by DAIKIN, TRANE, YORK, or approved equal.
- 2. Fan Coil Type and Arrangement
 - a. The fan coil shall be furnished as a draw-through cooling coil with a heating coil in preheat/reheat position.

3. Cabinet

- a. Unit shall be supplied with powder coat painted cabinet. Finish must meet ASTM B117 specifications (salt spray test).
- b. Unit shall be supplied with a decorative wall plate with powder coat paint. Finish must meet ASTM B117 specifications (salt spray test).

4. Supply Fan

- a. Supply fans shall be a DWDI forward-curved type. Fan assemblies including fan, motor and sheaves shall be dynamically balanced by the manufacturer on all three planes at all bearing supports. Manufacturer must ensure maximum fan RPM is below the first critical speed.
- The complete fan assembly, including motor and main drain pan shall be easily removable.
- c. Units shall be certified in accordance with the Room Fan Coil Unit certification program that is based on ARI Standard 440.
- d. ECM blower motor shall be 3 speeds, single phase with means for proportional field adjustment of each speed.

Electrical

a. Motor wires shall include a quick-disconnect motor plug.

6. Cooling and Heating

- a. Cooling Coils
 - 1) Cooling performance shall be as specified on the unit schedule.
 - Water coil fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Seamless copper tubes shall be mechanically expanded into the fins to provide a continuous primary-to-secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins. Coil casing shall be constructed of galvanized steel.
 - Water coils shall be provided with headers of seamless copper tubing with intruded tube holes to permit expansion and contraction without creating undue stress or strain. Coil connections shall be copper sweat connections with connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain connections shall be furnished on the coil connection, external to the cabinet. Vent connections shall be provided at the highest point to ensure proper venting. Drain connections shall be provided at the lowest point.
 - 4) All steel parts exposed to moisture shall be galvanized.
 - 5) Unit shall include a noncorrosive, galvanized main drain pan, positively sloped in every plane and insulated with closed-cell insulation. The drain

- pan shall be designed to ensure no pooling of condensate water per ASHRAE 62.2.
- 6) Unit shall include a noncorrosive, ABS main drain pan, positively sloped in every plane and insulated with closed-cell insulation. The drain pan shall be designed to ensure no pooling of condensate water per ASHRAE 62.2.
- 7) Water Heating Coil
 - a) Heating performance shall be as specified on the unit schedule.
 - b) Coil fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Seamless copper tubes shall be mechanically expanded into the fins to provide a continuous primary-to-secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
 - c) Coils shall be provided with headers of seamless copper tubing with intruded tube holes to permit expansion and contraction without creating undue stress or strain. Coil connections shall be copper sweat connections with connection size to be determined by manufacturer based upon the most efficient coil circuiting. Drain connections shall be furnished on the coil connection, external to the cabinet. Drain connections shall be provided at the lowest point.
 - d) Heating coil shall be installed in the reheat position.
- 7. Filters
 - Filters shall be 2" MERV 11 filter. They shall be concealed from sight and easily removable.
- 8. Controls
 - a. Unit controller shall be supplied by DDC contractor.
 - b. Refer to specification Section 230900 and the Automatic Temperature Controls diagrams in the drawings for unit controller requirements.

2.06 HVAC PIPING AND SPECIALTIES

- A. Piping
 - 1. Water, refrigerant, and HVAC drain piping shall be provided as specified below. Where options of different materials are given for the same service, contractor shall select materials and use them uniformly throughout the system. Contractor shall submit experience with all of the materials and joining methods specified.
 - 2. Chilled and Hot water piping:
 - a. Above ground
 - 1) Type L copper (2 inch and under)
 - 2) Schedule 40 black steel (2 inch and under)
 - 3) Schedule 40 black steel (2-1/2 inch and over)
 - b. Threaded steel Piping
 - 1) Schedule 40 black steel (2 inch and under)
 - 3. Condensate drain piping:
 - a. Above ground (within building and plenum rated ceiling)
 - 1) Type L copper
 - b. Above ground (exterior to building)

- 1) Schedule 40 PVC
- c. Below ground: refer to Specification Section 220500 Plumbing
- 4. Drain piping in mechanical equipment rooms:
 - a. Above ground
 - 1) Type L copper
- 5. Type L copper pipe shall conform to ASTM B42, and be assembled with wrought-copper soldering fittings using 95-5 solder or with press on fittings as specified herein.
- 6. Schedule 40 PVC pipe shall be assembled in strict accordance with manufacturer's instructions. Solvent cement shall conform to ASTM D2564.
- 7. Schedule 40 black steel pipe shall be fabricated by welding using Schedule 40 steel welding fittings conforming to ASTM A53.
- 8. Press on Connector Fittings
 - Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and NSF/ANSI Standard (NSF 61). Sealing elements for press fittings shall be factory installed EPDM.
 - b. Press—connected fittings 1/2" 2" press end shall have a leak-before-press feature, which assures leakage from inside the system past the sealing element of an unpressed connection. Fittings 2 1/2" 4" press end shall have a factory installed means for visual inspection of completed press.
 - c. Copper press fitting joints shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tuning marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark in the tubing to ensure the tubing is fully inserted in the fitting. The joints shall be pressed using the pressing tool and jaws or jaw set, approved by the fitting manufacturer.
 - d. Fitting installer shall be trained by the fitting manufacturer's factory representative.
 - e. Press connected fittings shall be by ELKHART PRODUCTS CORP., NIBCO, VIEGA or approved equal.
- 9. Piping shall be run concealed, except where no ceiling is provided. Coordinate installation of piping with other disciplines. Locate all piping tight against structure where possible. No piping shall be installed below mechanical equipment, or within mechanical or electrical equipment clearance requirements.
- 10. Pitch hydronic piping to vent at high points and provide accessible drains at low points.

B. Valves:

1. Valves 2" size and under shall be bronze with soldered ends, rough bodies, and finish trim. Valves 2-1/2" size and over shall be iron-body, bronze-mounted with flanged ends, except where specifically indicated. Valves on cold or chilled piping shall have extended shafts to match the pipe insulation thickness to prevent condensation. Catalog numbers indicated below are NIBCO. Valves with equivalent characteristics by APOLLO, or MILWAUKEE are acceptable.

Size	Pipe Material	Globe	Check	Ball/Butterfly
2" and under	Copper	S-235	S-413-Y	S-585-70-66NS
2-1/2" and over	Copper	F718-B	F918-B	LC-2000
2-1/2" and over	Steel	F718-B	F918-B	LC-2000

- 2. Check valves in pump discharge lines shall be NIBCO F-910 "silent check valve,". Valves with equivalent characteristics by APOLLO, or MILWAUKEE are acceptable.
- 3. Balancing valves 2" and smaller shall be NIBCO S-585-70-66NS. Balancing valves 2-1/2" and larger shall be butterfly valves as specified below. Valves shall be complete with memory stops. Valves on cold or chilled piping shall have extended shafts to match the pipe insulation thickness to prevent condensation. Valves with equivalent characteristics by APOLLO, or MILWAUKEE are acceptable.
- 4. Butterfly valves used for balancing purposes shall be cast iron, lug type and suitable for dead-end service, 200 psig, bubble-tight shutoff, and 250°F service. Disc shall be aluminum bronze with 416 stainless-steel extended shaft and copper or brass bushings. Seat shall be EPDM. Provide lever actuators with ten positions with memory stops. Valves on cold or chilled piping shall have extended shafts to match the pipe insulation thickness to prevent condensation. NIBCO LC-2000, or approved equal. Valves 6" and above shall be provided with gear operators. Valves with equivalent characteristics by APOLLO, or MILWAUKEE are acceptable.
- 5. Pressure Relief Valves:
 - a. Provide ASME-rated bronze body, direct spring-loaded, diaphragm-type, leveroperated relief valve with factory-set discharge pressure. Valve body shall have threaded connections and be designed for a working pressure of 150 psi. Fluid shall not discharge into spring chamber.
 - b. Provide relief valves on low pressure side of pressure reducing valves where indicated.
 - c. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity.

2.07 **PUMPS**

- A. Base Mounted End Suction Circulating Pumps (P-1 through P-4)
 - Pumps shall be size, type, have capacity and arrangement as indicated, designed for service encountered. BELL & GOSSETT, or equal by TACO, WILO, WIENMEN, OR PATTERSON.
 - 2. End suction pumps shall be bronze fitted, cast-iron case. Pumps shall be base-mounted, single stage, end suction design.
 - a. Pump volute shall be made of cast iron with integrally cast pedestal support. The impeller shall be cast bronze, enclosed type, statically and hydraulically balanced. Impeller shall be keyed to the shaft and secured by a hex head impeller nut and washer.
 - b. Pumps shall be provided with a single inside unbalanced mechanical shaft seal for leakless operation. A suitable arrangement shall be provided to furnish a portion of the pumped liquid to lubricate and cool the seal faces.
 - c. Pump shall be rated for a minimum of 175 psi working pressure. Casings shall be provided with tapped and plugged holes for priming, vent, and drain.
 - d. Pump bearing housing shall have heavy duty re-greaseable ball bearings.
 - e. Baseplate shall be channel steel, sufficiently rigid to support the pump and driving motor.
 - f. A flexible-type coupler, capable of absorbing torsional vibration, shall be employed between the pump and motor, and it shall be equipped with a suitable coupling guard as required. Contractor to level and grout each unit according to manufacturer's instructions.

- g. The motor shall be NEMA specifications and shall be the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned, and shall be realigned by contractor after installation.
- h. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.
- i. Each pump shall be checked by the contractor and regulated for proper differential pressure, voltage and amperage draw. This data shall be noted on a permanent tag or label and fastened to the pump for owner's reference.
- 3. Pumps shall be non-overloading over entire impeller curve within service factor of motor. Pumps shall be sized for a maximum discharge velocity of 16 FPS and a maximum suction velocity of 12 FPS.
- 4. Provide suction diffusers matched to pump and system piping for end suction pumps.
- 5. Provide Aegis Shaft Grounding Rings on all pump shafts to extend the life of the bearings.

2.08 STRAINERS

A. Y-Strainers:

- 1. Strainers shall be self-cleaning "Y" type, of same size as pipe in which it is installed.
- 2. Provide valved blow-off outlet with hose connection and cap on each strainer. Blow-off connections shall be at bottom of strainer and shall be of size equal to 1/2 the pipe up to a maximum of 2".
- Screen perforations shall be suitable for intended service. Provide micron screen for flushing of system.

2.09 SUCTION DIFFUSERS

- A. Contractor shall furnish and install a suction diffuser on the suction side of pumps as indicated on the drawings. Suction diffuser shall be as manufactured by Bell & Gossett or approved equal. Suction diffusers shall meet sizes and characteristics as specified in the following and as scheduled.
- B. Units shall consist of an angle type body with internal straightening vanes that run the full length of the diffuser and a combination diffuser/strainer/orifice cylinder with 3/16" diameter openings for pump protection. The orifice cylinder shall be equipped with a disposable bronze fine 16-mesh strainer, which shall be removed after system start-up. Orifice cylinder shall be designed to withstand pressure differential equal to pump shutoff head and shall have a free area equal to five times cross section area of pump suction opening. Vane length shall be no less than 2-1/2 times the pump connection diameter. Unit shall be provided with a connection point where a field fabricated support foot can be attached to carry weight of suction piping.
- C. Diffuser manufacturer shall be responsible for any reduction in pump performance or damage due to high pressure drops, internal failures of components or harmonic oscillations caused by the diffuser.

2.10 FLEXIBLE PIPE CONNECTORS

A. Furnish and install braided stainless-steel flexible metal pipe connectors as manufactured by MASON-MERCER, FLEX-HOSE CO., INC., or approved equal. Construction to be of annular corrugated close pitch hose of stainless steel with stainless-steel braid. End fittings shall be 150# plate steel flanges. Install per FLEX-HOSE recommendations in Bulletin PC 88/4. Connectors shall be a minimum of 24" long.

2.11 EXPANSION TANKS

- A. Pressurized Expansion Tanks:
 - 1. Tanks shall be ASME Code construction for 125 psi service, of sizes indicated. Tanks shall be pre-charged bladder type. BELL & GOSSETT Series "B-LA," or equal by TACO.

- a. Expansion tanks are ASME rated pre-charged bladder-type pressure vessels designed to absorb the expansion forces of heating/cooling system water while maintaining proper system pressurization under varying operating conditions.
- b. Tank shall have a heavy-duty bladder to contain system water to prevent tank corrosion and water logging problems.
- c. Maximum working pressure shall be 125 PSI and maximum operating temperature shall be 240°F.
- d. System connections shall be forged steel. Tank shell shall be carbon steel
- e. Bladder shall be heavy duty butyl rubber
- f. Tank shall be designed and constructed per ASME Section VIII, Division.
- g. Tanks shall be complete with system and drain connections, air charging valve connection, and lifting ring.
- h. Volume of tank indicated is acceptance volume.

2.12 AIR ELIMINATOR AND DIRT SEPARATOR

- A. Provide a coalescing type air eliminator and dirt separator on the chilled and hot water system and as indicated on the drawings, SPIROVENT Model VDN CSTM or equal. All combination units shall be fabricated steel, rated for 150 psig working pressure with entering velocities not to exceed 4 feet per second at specified GPM.
- B. Units shall include an internal bundle filling the entire vessel to suppress turbulence and provide high efficiency. The bundle must consist of a copper core tube with continuous wound copper medium permanently affixed to the core.
- C. A separate copper medium is to be wound completely around and permanently affixed to the internal element. Each eliminator shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation.
- D. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.
- E. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.
- F. Separator shall have the vessel extended below the pipe connections an equal distance for dirt separation.
- G. Air Eliminators shall be capable of removing 100% of the free air, 100% of the entrained air, and up to 99.6% of the dissolved air in the system fluid. Dirt separation shall be at least 80% of all particles 30 micron and larger within 100 passes.
- H. Separator shall include a removable flanged lower head to facilitate removal of assembly for inspection or cleaning.

2.13 THERMOMETERS

- A. Thermometers shall be provided as indicated. WEKSLER INSTRUMENT, Type "AF."
- B. Thermometers in pipelines shall be separable socket 5" dial bi-metal insertion type, with scale suitable for temperature range of medium being measured. Thermometers shall be located to facilitate reading from floor. Angle-type shall be used where necessary to facilitate reading. Install in thermal well in flow of fluid.
- C. Thermometer range shall be 0-150°F for chilled water and 30-240°F for hot water.

2.14 PRESSURE GAUGES

A. Pressure gages shall be provided on suction and discharge line of each pump and where indicated. WEKSLER INSTRUMENT, model AA-14-2.

B. Gages shall be bourdon spring type with 4-1/2" dial set in polypropylene case. Gauges shall be equipped with brass tee-handle shut-off cocks. Gauges shall have required range of 0-100 psig and not in more than 2 psi graduations.

2.15 AUTOMATIC BALANCING VALVES

- A. Automatic Balancing Valves:
 - 1. Provide NuTech Model AB, or approved equal, measuring and balancing valves where indicated for pipe sizes 1/2" to 2".
 - 2. The GPM for the automatic flow control valves shall be factory set and shall automatically limit the rate of flow to within 5% of the specified amount.
 - 3. For 1/2" 2", the flow cartridge shall be removable from the Y-body housing without the use of special tools to provide access for cartridge change out, inspection, and cleaning without breaking the main piping. (Access shall be similar to that provided for removal of a Y-strainer screen).
 - 4. True operating range of 2 32 psid required. The design flow should be achieved at the minimum psi differential. A 50% safety factor applied to the lower operating range is not acceptable.
 - 5. Each valve shall have two P/T ports.
 - 6. All automatic flow control devices shall be supplied by a single source.
 - 7. Five-year product warranty and free first year cartridge exchange.
 - 8. The internal wear surfaces of the valve cartridge must be Ultrason® composite or stainless steel.
 - 9. The flow cartridge design shall incorporate a stainless steel spring which requires no adjustment screw or shims. A crimped sheet-metal design is not acceptable.
 - 10. The internal flow cartridge shall be permanently marked with the GPM.
 - 11. For 1/2" through 2" pipe sizes: The valve shall consist of a brass Y-type body, O-ring-type union, and integral brass body ball valve with memory stop. The ball valve ID shall be minimum standard port (one size smaller than valve connection size). **Reduced port valves are not acceptable**. NuTech Model AB, or approved equal.
 - 12. For 2-1/2" and larger flanged connections: Ductile-iron body suitable for mounting wafer style between standard 150# or 300# flanges. The long flange bolts and nuts shall be provided with each automatic flow control valve. NuTech Model AW or approved equal.
 - 13. All valves shall be factory leak tested at 100 psi air under water.

14. Ratings: 1/2" through 2" pipe size: 600 PSIG at 250°F 2-1/2" through 12" pipe size: 600 PSIG at 250°F

- 15. Where indicated on the plans, the differential pressure across the automatic flow control valve shall be measured for flow verification and to determine the amount of system overheading or under-pumping. Where over-heading exist the ball valve shall be throttled to bring the flow cartridge back within the control range. The valve memory stop shall be set so the valve can be used for isolation and reopened to the balanced position.
- 16. The flow shall be verified by measuring the differential pressure across the coil served or the wide-open temperature control valve and calculating the flow using the coil or valve C_v
- 17. A differential pressure test kit shall be supplied to verify flow and measure over-heading. The kit shall consist of a 4-1/2" diaphragm gauge equipped with 10-foot hoses and P/T adapters, all housed in a vinyl case. Calibration shall be 0-35 PSID for 2-32 PSI spring range or 0-65 PSID for 5-60 PSI range.

- 18. Install automatic flow control valves on the return lines of coils as indicated on the plans. Balancing valve on supply side is not acceptable. Submit proposed piping arrangement for approval by the Engineer.
- 19. The standard ports and handles shall clear 1" thick insulation. Handle and port extensions are required for over 1" thick insulation.
- 20. Install, on the supply side of coils, a Y-strainer with a brass blow-down valve with 3/4" hose end connection with cap and chain.

2.16 TEST STATIONS

- A. Test Stations Pressure/Temperature (PT):
 - Install a 1/4" NPT fitting (Test Plug) of solid brass with brass chain at indicated locations.
 Test plug shall be capable of receiving either a pressure or temperature probe 1/8" o.d.
 Dual seal core shall be neoprene for temperature to 200°F and shall be rated zero
 leakage from vacuum to 1,000 psig. PETERSON EQUIPMENT COMPANY, SISCO, or
 approved equal.
 - 2. One Master Test Kit shall be provided to the Owner. Kit shall contain one 2-1/2" pressure gage of suitable range, one Gage Adapter 1/8" o.d. probe, and one 5" stem pocket testing thermometer 0° to 220°F.

2.17 AIR VENTS

- A. Provide manual air vents where indicated, and where required to properly and adequately vent heating system of air. Vent shall utilize a ball valve with handle in lieu of key operated.
- B. Provide automatic air vents where indicated (in Mechanical Room only). BELL & GOSSETT Model 107, or approved equal.

2.18 CHEMICAL SHOT FEEDER

- 1. Provide one feeder for each the chilled water and hot water systems NEPTUNE, WALCO or equal.
- 2. Tanks shall be ASME Code construction for 125 psi service, 5-gallon chemical shot feeder. Feeder shall include funnel and isolation valves.

2.19 HEAT TRACE

- A. The heater in combination with the interconnecting components shall be UL Listed. The self-regulating heater shall consist of two (2) #16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperatures all along its length, allowing the heater to be crossed over itself without overheating, to be used directly on plastic pipe, and to be cut to length in the field. The heater shall be covered by a tinned-copper metallic over-shield and a thermoplastic elastomer over-jacket. The heater and equipment protection shall conform with NEC Code. The heater shall operate on line voltages as shown on the drawings without the use of transformers. The heater shall be selected by the manufacturer and installed to maintain a minimum water temperature of 35°F at an ambient temperature of -10°F.
- B. The heater shall be as manufactured by HEAT TRACE PRODUCTS, LLC., 2700 Series, or an approved equal
- C. The heater shall be sized according to this table. The required heater output rating is in watts per foot when engaged at 50°F. (Heater selection based on 1" fiberglass insulation on metal piping).

Pipe Size	Single or Double Traced	Watts/LF
6" or less	Single Traced (1 strip)	8
8" or more	Dual Traced (2 strips)	8

D. Power connection and seal, splice, and tee kit components shall be supplied by the manufacturer and applied in the field.

- E. Heat trace circuit shall be controlled by a terminal controller. The controller shall be supplied and installed by the contractor. The controller shall be equipped with an ambient temperature sensor and a contact for alarm monitoring via the BAS. The controller shall enable the heater when an ambient temperature of less than 50°F is sensed. The controller shall disable the heater when an ambient temperature of greater than 40°F is sensed.
- F. Each heat trace circuit shall be monitored by the BAS. The BAS shall monitor the heat trace system using the controller's integral alarm contact.
- G. Run the heater linearly along the underside of the pipe after piping has been successfully pressure tested. Secure the heater to piping with fiberglass tape.
- H. Install heating cable strictly in accordance with manufacturer's recommendations. Provide wrapping per manufacturer's recommendations for valves, fittings, etc. Also provide additional coverage for locations where pipe goes below grade.
- I. Apply "electric traced" signs to the outside of the thermal insulation, one every 10 linear feet.
- J. All piping that is protected by heating cable shall have insulation. Insulation shall extend 12" into heated space or 12" beyond the area where water normally stands in the pipe.
- K. Coordinate the location and amperage of the heat tracing circuits with the Division 26 installer.
- L. The Heat Trace equipment shall be provided with an Electronic Thermostat Control with Ground Fault Equipment Protection, as manufactured by ETI model TRACON FPT 130, or approved equal. For wiring and installation responsibilities by Contractor division, see the mechanical detail "Heat Trace Terminal Controller" located in the Mechanical drawings of the contract documents.
- M. Contractor shall be responsible for a complete working system.
- N. After installation and before and after installing the thermal insulation, subject heat tape to testing using a 1,000-VDC megger and 12-volt DC test to verify cable paths. Minimum insulation megger resistance reading should be 20 to 1,000 megohms regardless of length. Provide field test report to the Engineer after each successful test.
- O. After the final layout for exterior piping been created by the Contractor, the Contractor shall submit the layout to the Heat Trace Cable manufacturer to determine the required heat trace length. If it exceeds the circuit maximum listed in the schedule, the Contractor shall coordinate an additional circuit with Heat Trace Cable manufacturer.
- P. If the Contractor chooses to have the Heat Trace supplier install the heat trace cable and/or Thermostat Controller, the power wiring must be completed by the Division 26 Contractor. See "HEAT TRACE THERMOSTAT CONTROLLER DETAIL" for more information.

2.20 AIR DISTRIBUTION

- A. Ductwork
 - 1. Provide all ducts, plenums, connections, dampers, and related items required to form a complete system as indicated on drawings and specified herein.
 - 2. All ductwork shall be sheet metal.
 - 3. Sheet-metal ducts shall be fabricated from G60 galvanized-steel sheets, 304 stainless steel, or 3003 aluminum, and shall be of gauges called for and as detailed in 2005 SMACNA Manual, HVAC Duct Construction Standards (Metal and Flexible). All constant volume ductwork shall be 1" w.g. pressure class construction and shall be single-wall rectangular or round.
 - 4. Duct sealing requirements shall be Class A for all ductwork except for the following which may be Class B:
 - a. Exhaust in conditioned spaces
 - b. Supply duct <2" w.g. operating pressure in conditioned spaces
 - c. Return duct in conditioned spaces

- 5. I ductwork shall not be delivered to the job site until just prior to erection. Ductwork with dents or other damages shall not be accepted.
- 6. Rectangular low velocity ductwork shall be constructed from galvanized steel sheets of lock form quality per ASTM A653 with a G60 zinc coating (0.60 oz/ft²), unless otherwise shown on the contract documents. Sheets shall be free of pits, blisters, slivers, and ungalvanized spots.
- 7. Insulated-flexible acoustical air ducts shall be FLEXMASTER USA TYPE 1M. THERMAFLEX Type M-KE, or approved equal, suitable for up to 10" w.g. positive pressure and rated velocity of 5500 FPM. Flexible ductwork shall meet NFPA 90A standards, conform to UL standard 181, and be ETL listed Class 1 air duct. Flexible duct shall have a flame spread of less than 25 and smoke developed of less than 50. Flexible ductwork shall be fabricated with a polyethylene or chlorinated polyethylene inner film, wrapped in 2" thick with a thermal conductance of R-6 fiberglass insulation, with an outer reinforced metallized vapor barrier. The inner film shall be supported by a corrosion resistant galvanized steel helix formed and mechanically locked to the polyethylene fabric. The inside bend radius shall be ½ x inside diameter in all sizes. Flexible branch ductwork to diffusers shall be limited to maximum length of 5 feet long and maximum velocity of 600 feet per minute. Flexible duct connections at variable air volume terminals shall be a maximum of 3 feet long. Contractor to provide proper flex duct size to ensure velocity limit is not exceeded. Support flexible ducts a minimum of every 4 feet. Supports shall not compress or constrict the flexible duct. Refer to the diffuser installation details on the drawings.
- 8. Provide flexible connections of fiberglass between ducts and air-handling unit connections, fan coil units, and exhaust fans. Connector shall be constructed using double lock gripping fingers at metal to fabric contact. Connector shall be rated airtight and watertight up to 10" w.g. positive to 10" w.g. negative pressure. Provide flexible connections, not less than 4 inches wide, constructed of approved fireproof, waterproof, non-asbestos, glass fabric, at the inlet and outlet connection of each fan unit, securely fastened to the unit and to the ductwork by a 24 gauge galvanized steel band provided with tightening screws. There shall be no metal-to-metal contact at flexible connections. There shall be no stretching of the flexible material at flexible connections. The connection shall be UL listed, to meet NFPA 90A and 90B requirements and the following applications:

Indoor: Neoprene coated glass fabric, minimum 30 oz./sq.yd., DUCTMATE "PROFLESTM" or approved equal.

Outdoor: U.V. resistant Hypalon coated glass fabric, minimum 24 oz./sq.yd. DUCTMATE "PROflexTM" or approved equal.

- 9. Insulated duct shall have saddle hangers. Suspended duct hangers attached to the side of the ductwork are acceptable. Refer to duct support details on the drawings.
- 10. Fabricate ductwork with airtight joints, presenting smooth surface on inside, neatly finished on outside; construct with curves and bends to aid in easy flow of air. Unless otherwise indicated, make inside radius of curves and bends at least width of ducts. Where square elbows have to be used, provide double wall turning vanes in all elbows. Deflecting vanes shall be double wall blades, fit into side rails, and screw or rivet to duct elbow in field. Blades and side strips shall be small or large double vanes as detailed in SMACNA Duct Manual. DUCTMATE "PROrailtm" or approved equal.
- Construct, brace, and support ducts and air chambers in a manner that they will neither sag nor vibrate to any perceptible extent when fans are operating at maximum speed or capacity.
- 12. Provide sandwich type or square framed access doors for service temperature and pressure required, where indicated and where not indicated, in locations and of sizes which will afford easy access to multi-blade dampers, smoke detectors, fire dampers, and

other equipment and devices requiring inspection and servicing. Access doors shall be installed to avoid lights, piping, conduit, ceiling grid, etc., to provide unobstructed access. Access doors shall be installed on the underside of the ductwork. Access doors shall be a minimum of 24" x 18" where possible. Access doors in all factory fabricated ductwork shall be factory installed and sizes and locations shall be identified on the ductwork shop drawing submittal. In non-accessible ceilings, provide access doors in ceiling. DUCTMATE or approved equal.

- 13. Connect ductwork to intake and discharge louvers, dampers, and other work installed in various trades requiring sheet-metal connections.
- Make sheet-metal connections to masonry work airtight and watertight in approved manner.
- 15. Provide opposed-blade dampers for control of air volume and for balancing system, where indicated or required. Dampers shall be of sheet metal at least one gauge heavier than duct and reinforced; shall be installed in an accessible location. Provide indicating quadrant and locking device for adjusting and locking dampers in position. Provide extended shafts on all volume dampers greater than the thickness of the insulation to provide free movement of damper positioner. Stiffen duct at damper location, install damper in manner to prevent rattling.
- 16. Provide square to round transition fittings with balancing damper at all round-duct takeoffs to supply diffusers and registers.
- 17. Provide access doors in building walls and ceilings where damper quadrants are concealed in shafts or above non-accessible ceilings.
- 18. Duct sizes are inside free area. Increase duct sizes as required.
- 19. Ductwork and accessories shall not be delivered to the job site until just prior to erection and must be stored in an approved manner.
- 20. All ductwork shall be internally cleaned by vacuuming prior to installation.
- 21. All ductwork open ends shall be sealed with polyethylene and duct tape during construction after hanging.
- B. Grease Duct (Double-Wall Construction):
 - 1. The grease duct shall be double-wall factory-built type for use with Type 1 kitchen hoods, as described in NFPA-96 for the venting of air and grease-laden vapors from commercial cooking operation.
 - 2. Basis of design product shall be Jeremias "DWFL-ZC/DWGD-RZ". Acceptable alternate products are CaptiveAire "DW-2R/DW-3Z" or "FYREGUARD" by The Schebler Company.
 - 3. Product Description
 - a. The factory-built modular grease duct shall be laboratory tested and listed in accordance with Underwriters Laboratories Standard UL 1978 and UL 2221 classified for zero clearance to combustibles with a 2-hour fire rating. Sections shall bear the UL listing mark. Modular grease duct shall be a 1/2" flange to flange connection and sections shall be coupled using RapidLock™ bands and joint sealant.
 - b. Construction: Between the inner and outer shells there shall be a minimum 4" of 1800°F rated low conductivity ceramic fiber insulation. The insulation is to be securely attached to the inner shell with steel straps and insulating pins welded to the inner shell. Stainless steel centering clips shall be welded to the outer shell to maintain the 4" spacing and ensure concentricity of the shells. Breeching and chimney sections, when installed according to manufacturer's instructions, shall comply with national safely standards and building codes. Stacks terminating above a roof must terminate as required by code or NFPA 211.

- c. Inner Shell: Inner shell material shall be type 304 stainless steel. Inner shell thickness shall be .036" for 5" to 36" diameter systems. All inner shell seams shall be fully penetration welded the entire length of the pipe section. Riveted, tack or spot-welded seams are not permitted.
- d. Outer Jacket: Standard 430 stainless steel outer shell thickness of .034" for 5" to 36" diameter systems. All outer shell seams shall be full-penetration-welded the entire length of the pipe section. Riveted, tack or spot-welded seams are not permitted.
- e. Accessories: Rain caps, tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
- f. Warranty: Manufacturer Lifetime Warranty for the entire duration the product is incorporated and used in its original installation when properly installed by manufacturer's provided UL installation instructions. System sizing and design must be performed by manufacturer and installed in accordance with the installation instructions published.

4. Installation and Cleaning

- a. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- b. Seal between sections of grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- c. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- d. Slope breechings down in the direction of the appliance.
- e. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- f. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film.
- g. Provide temporary closures at ends of stacks that are not completed or connected to equipment.

2.21 VIBRATION ISOLATORS

- A. Mechanical equipment indicated below shall be isolated from the structure by resilient vibration and noise isolations. Equipment to be isolated includes, but is not limited to, the following: FCUs, DOAS-(2 and 3) and AHU-1.
 - 1. Spring Isolators:
 - a. DOAS-2, DOAS-3 and AHU-1 shall be mounted on spring mountings, including the neoprene acoustical pad within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed and temporary steel spacers between the upper and lower housings. Housings shall serve as blocking during erection. When the equipment is at full operating weight, the springs shall be adjusted to assume the weight and the spacers removed, without changing the installed and operating heights. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical as well as horizontal modes. The hole through the bushing shall be a minimum of 3/4" (19mm) larger in diameter than the restraining bolt. Horizontal clearance on the sides between the spring assembly and the housing shall be a minimum of 1/2" (13mm) to avoid bumping and interfering with the spring action. Vertical limit

- stops shall be out of contact during normal operation. Housings and springs shall be powder coated and hardware electro-galvanized. Mountings shall be Type SLRSO as manufactured by Mason Industries, Inc or approved equal.
- b. Indoor FCUs and fans shall be suspended with vibration spring isolators Type 30N as manufactured by MASON INDUSTRIES, INC. or approved equal.
- c. Hangers shall consist of rigid steel frames containing minimum 1-1/4" thick neoprene elements at the top and a steel spring seated in a steel washer reinforced neoprene cup on the bottom. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. In order to maintain stability, the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring.

2.22 MEASUREMENT AND CONTROL

- A. Variable Speed (Frequency) Drive Units:
 - All variable speed drives shall contain a Siemens P1 chip for RS232 interface to the Siemens MEC Controller.
 - 2. Provide variable speed frequency drive (VFD) units for the following equipment:
 - a. AHU Supply Fan
 - b. AHU Exhaust Fan
 - c. DOAS Supply Fans
 - d. DOAS Exhaust Fans
 - e. DOAS Energy Wheels
 - f. Pumps
 - Manufacturers:

ASEA BROWN BOVERI DANFOSS GRAHAM TOSHIBA

- 4. This specification is to cover a complete Adjustable Frequency motor Drive (AFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard Design B induction motor.
- 5. The drive manufacturer shall supply the drive and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of 20 years.
- 6. Referenced Standards:
 - a. Institute of Electrical and Electronic Engineers (IEEE): Standard 519-1992, IEEE Guide for Harmonic Content and Control.
 - b. Underwriters Laboratories: UL 508C.
 - c. National Electrical Manufacturer's Association (NEMA): ICS 7.0, AC Adjustable Speed Drives.
 - d. IEC 16800 Parts 1 and 2.
- 7. Qualifications:

- a. AFDs and options shall be UL listed as a complete assembly. AFDs that require the customer to supply external fuses for the AFD to be UL listed are not acceptable. The base AFD shall be UL listed for 100 KAIC without the need for input fuses.
- b. CE Mark The AFD shall conform to the European Union ElectroMagnetic Compatibility directive, a requirement for CE marking. The AFD shall meet product standard EN 61800-3 for the First Environment restricted level.
- c. The AFD manufacturer shall have available a comprehensive, HVAC Drive Computer Based Training (CBT) product. The CBT product shall include detailed, interactive sections covering AFD unpacking, proper mechanical and electrical installation, and programming. The CBT product shall allow the user to provide just-in-time training to new personnel or refresher training for maintenance and repair personnel on the user's site. The CBT product shall be repeatable, precise, and shall include record keeping capability. The CBT product shall record answers to simulations and tests by student ID. The CBT product must be professionally produced and have interactive sections, student tests, and include video clips of proper wiring and installation.
- 8. Submittals: Submittals shall include the following information:
 - a. Outline dimensions, conduit entry locations and weight.
 - b. Customer connection and power wiring diagrams.
 - c. Complete technical product description include a complete list of options provided.
 - d. Compliance to IEEE 519 harmonic analysis for particular job site, including total harmonic voltage distortion and total harmonic current distortion (TDD).
 - e. The AFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by the AFD manufacturer to ensure compliance with IEEE standard 519. All AFDs shall include a minimum of 5% impedance reactors, no exceptions.
- 9. Adjustable Frequency Drives:
 - a. The AFD package as specified herein shall be enclosed in a UL Listed completely assembled and tested by the manufacturer in an ISO9001 facility. The AFD tolerated voltage window shall allow the AFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum. Refer to Section 230500 for NEMA enclosure requirements.
 - b. Environmental Operating Conditions: 0 to 40°C continuous. AFDs that can operate at 40°C intermittently (during a 24-hour period) are not acceptable and must be oversized. Altitude 0 to 3,300 feet above sea level, less than 95% humidity, non-condensing.
 - c. Enclosure for indoor applications shall be rated UL Type 1, Enclosures for outdoor applications shall be UL Type 3R (4X-SS for VBCPS). All enclosures shall be UL listed as a plenum rated VFD.
 - d. All AFDs shall have the following standard features:
 - All AFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple AFDs.
 - 2) The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed

- reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.
- 3) There shall be a built-in time clock in the AFD keypad. The clock shall have a battery backup with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the AFD shall automatically revert to hours of operation since initial power up. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. The AFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.
- 4) The AFDs shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The AFD shall have two user macros to allow the end-user to create and save custom settings.
- 5) The AFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the AFD from the wall or removal of circuit boards. The AFD cooling fans shall operate only when required. To extend the fan and bearing operating life, operating temperature will be monitored and used to cycle the fans on and off as required.
- 6) The AFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
- 7) The AFD shall have the ability to automatically restart after an overcurrent, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.
- 8) The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.
- 9) The AFD shall have an integral 5% impedance line reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. AFDs with only one DC reactor shall add AC line reactors.
- 10) The input current rating of the AFD shall be no more than 3% greater than the output current rating. AFDs with higher input current ratings require the upstream wiring, protection devices and source transformers to be oversized per NEC 430-2.
- 11) The AFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOVs (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.
- 12) The AFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include

- programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.
- 13) If the input reference (4-20 mA or 2-10V) is lost, the AFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the AFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communication bus.
- 14) The AFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.
- e. All AFDs to have the following adjustments:
 - 1) Three (3) programmable critical frequency lockout ranges to prevent the AFD from operating the load continuously at an unstable speed.
 - Two (2) proportional/integral/derivative (PID) Setpoint controllers shall be 2) standard in the drive, allowing pressure or flow signals to be connected to the AFD, using the microprocessor in the AFD for the closed loop control. The AFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID setpoint shall be adjustable from the AFD keypad, analog inputs, or over the communications bus. There shall be two parameter sets for the first PID that allow the sets to be switched via a digital input, serial communications or from the keypad for night setback, summer/winter setpoints, etc. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain setpoint of an independent process (i.e., valves, dampers, etc.). All setpoints, process variables, etc., to be accessible from the serial communication network. The setpoints shall be set in Engineering units and not require a percentage of the transducer input.
 - 3) Two (2) programmable analog inputs shall accept current or voltage signals.
 - 4) Two (2) programmable analog outputs (0-20 mA or 4-20 mA). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.
 - 5) Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices, typically programmed as follows:
 - a) There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications) the AFD shall provide a dry contact closure that will signal the damper to open (AFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to an AFD digital input and allows AFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. The keypad shall display "start enable 1 (or 2) missing". The safety status shall also be transmitted over the serial communications bus. All digital inputs

shall be programmable to initiate upon an application or removal of 24VDC.

- 6) Three (3) programmable digital Form-C relay outputs. The relays shall include programmable on and off delay times and adjustable hysteresis. Default settings shall be for run, not faulted (fail safe), and run permissive. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs shall be true form C type contacts; open collector outputs are not acceptable.
- 7) Seven (7) programmable preset speeds.
- 8) Two independently adjustable accel and decel ramps with 1 1800 seconds adjustable time ramps.
- 9) The AFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.
- 10) The AFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual AFD temperature that allows the highest carrier frequency without derating the AFD or operating at high carrier frequency only at low speeds.
- 11) The AFD shall include password protection against parameter changes.
- f. The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alphanumeric codes are not acceptable). The keypad shall utilize the following assistants:
 - 1) Start-up assistants.
 - 2) Parameter assistants
 - 3) Maintenance assistant
 - 4) Troubleshooting assistant
- g. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alphanumeric codes are not acceptable):
 - 1) Output Frequency
 - 2) Motor Speed (RPM, %, or Engineering units)
 - 3) Motor Current
 - 4) Calculated Motor Torque
 - 5) Calculated Motor Power (kW)
 - 6) DC Bus Voltage
 - 7) Output Voltage
- h. The AFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the AFD shall operate at an adjustable preset speed. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the AFD shall resume normal operation.
- i. Serial Communications:
 - The AFD shall have an RS 485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Optional protocols for LonWorks, BACnet, Profibus,

Ethernet, and DeviceNet shall be available. Each individual drive shall have the protocol in the base AFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed.

2) The BACnet connection shall be an RS 485, MSTP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:

Data Sharing – Read Property
Data Sharing – Write Property
Device Management – Dynamic Device Binding
Device Management – Dynamic Object Binding
Device Management – Communication Control

If additional hardware is required to obtain the BACnet interface, the AFD manufacturer shall supply one BACnet gateway per drive. Multiple AFDs sharing one gateway shall not be acceptable.

- Serial communication capabilities shall include, but not be limited to; run-3) stop control, speed set adjustment, PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the AFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote AFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus - keypad "Hand" or "Auto" selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass (if bypass is specified). The DDC system shall also be able to monitor if the motor is running in the AFD mode or bypass mode (if bypass is specified) over serial communications. A minimum of 15 field parameters shall be capable of being monitored.
- 4) The AFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any AFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the DDC system.
- 5) The AFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass valve control, chilled water value control, etc. Both the AFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The AFD shall keep the last good setpoint command and last good DO & AO commands in memory in the event the serial communications connection is lost.

- j. EMI / RFI filters. All AFDs shall include EMI/RFI filters. The onboard filters shall allow the AFD assembly to be CE Marked and the AFD shall meet product standard EN 61800-3 for the First Environment restricted level.
- k. All AFDs through 60HP shall be protected from input and output power miswiring. The AFD shall sense this condition and display an alarm on the keypad.
- I. The following shall be furnished and mounted by the drive manufacturer. All features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL 508 label.
 - A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor. Overload protection shall be provided in both drive and bypass modes.
 - 2) Door interlocked, pad lockable molded case switch that will disconnect all input power from the drive and all internally mounted options.
 - 3) The drive / bypass shall provide single-phase motor protection in both the AFD and bypass modes.
 - 4) The following operators shall be provided:

Bypass Hand-Off-Auto Drive mode selector Bypass mode selector Bypass fault reset

 The following indicating lights (LED type) shall be provided. A test mode or push to test feature shall be provided.

Power-on (Ready)

Run enable (safeties) open

Drive mode select damper opening

Bypass mode selected

Drive running

Bypass running

Drive fault

Bypass fault

Bypass H-O-A mode

Automatic transfer to bypass selected

Safety open

Damper opening

Damper end-switch made

6) The following relay (form C) outputs from the bypass shall be provided:

System started

System running

Bypass override enabled

Drive fault

Bypass fault (motor overload or underload (broken belt)

Bypass H-O-A position

- 7) The digital inputs for the system shall accept 24V or 115VAC (selectable). The bypass shall incorporate internally sourced power supply and not require an external control power source.
- 8) Customer Interlock Terminal Strip provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes (not functional in Fireman's Override 2). The remote start/stop contact shall operate in AFD and bypass modes.

- Class 20 or 30 (selectable) electronic motor overload protection shall be included.
- Installation shall be the responsibility of the Mechanical Contractor. The Contractor shall install the drive, in accordance with the recommendations of the AFD manufacturer as outlined in the installation manual.
- 11. Power wiring shall be completed by the Electrical Contractor unless otherwise noted as factory wired. The Contractor shall complete all wiring in accordance with the recommendations of the AFD manufacturer as outlined in the installation manual.
- 12. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the Owner, and a copy kept on file at the manufacturer.
- 13. Factory trained application engineering and service personnel that are thoroughly familiar with the AFD products offered shall be locally available at both the specifying and installation locations. A 24/365 technical support line shall be available on a toll-free line.
- 14. A computer-based training CD or 8-hour professionally generated video (DVD format) shall be provided to the Owner at the time of project closeout. The training shall include installation, programming, and operation of the AFD, bypass, and serial communication.
- 15. Warranty shall be 24 months from the date of certified start-up. The warranty shall include all parts, labor, travel time, and expenses. There shall be 365/24 support available via a toll-free phone number.
- B. Low Voltage Condensate Overflow Shut-off Switch
 - 1. Low voltage condensate overflow shut-off switches shall be installed on all condensate drain pans as manufactured by RECTORSEAL approved equal.
 - The condensate shut-off switch shall detect rising water in condensate drain pans and interrupts the thermostat circuit to shut off the unit before flooding occurs. The device shall be installed on the primary drain pan rim with a two-piece clamp system that does not require drilling.
 - 3. Mechanical equipment without adequate pan clearance to install a primary drain pan switch shall provide a switch installed on the primary drain pan outlet. The condensate shut-off switch shall detect downstream clogs in condensate drains and interrupts the thermostat circuit to shut off the unit before flooding occurs.
 - 4. The switch shall incorporate a high capacity 5-amp, 24-volt AC magnetic float switch in a fully housed protective cover. The housing shall include a pull up test knob for functional testing of system.
 - 5. The switch shall include an alarm wire to connect to the BAS. The switch shall send an alarm signal to the BAS frontend workstation. The mechanical contractor shall be responsible for coordinating the switch connections with the controls contractor.
 - 6. The switch shall be UL Listed to comply with UL 508.

2.23 AIR PURIFICATION SYSTEM

- 1. This section describes the design, performance and installation of an air purification system intended for use as part of another manufacturer's air handling unit or mounted on the duct as shown on the plans, details and equipment schedules.
- 2. The air purification system(s) shall be of the size, type, arrangement and capacity indicated and required by the unit furnished and manufactured by GLOBAL PLASMA SOLUTIONS model GPS-Ibar or GPS-FC based on equipment requirements below, AMERICAN ION, ACTIVE AIR SOLUTIONS, PHENOMENAL AIRE, or approved equal.
- 3. Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a Plasma Generator with Bi-polar Ionization output as described here within.

- 4. The Bi-polar Ionization system shall be capable of:
 - a. Effectively killing microorganisms downstream of the bi-polar ionization equipment (mold, bacteria, virus, etc.).
 - b. Controlling gas phase contaminants generated from human occupants, building structure and furnishings.
 - c. Capable of reducing static space charges.
 - d. All manufacturers shall provide documentation by an independent NELEC accredited laboratory that proves the product has minimum kill rates for the following pathogens given the allotted time and in a space condition:
 - 1) MRSA >96% in 30 minutes or less
 - 2) E.coli > 99% in 15 minutes or less
 - 3) TB > 69% in 60 minutes or less
 - 4) C. diff >86% in 30 minutes or less
 - e. The ionization device shall be designed such that it may fit into any scheduled mounting configuration. The ionization device shall be powered from the control board without having to require revised fusing.
 - f. The bi-polar ionization system shall operate in a manner such that equal amounts of positive and negative ions are produced. Uni-polar ion devices shall not be acceptable.
 - g. Humidity: Plasma Generators shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 100%, condensing, shall not cause damage, deterioration or dangerous conditions within the air purification system. Air purification system shall be capable of wash down duty.

5. Ionization Requirements:

- a. The Bi-polar ionization system shall consist of Bi-Polar Plasma Generator and integral power supply. The Bi-polar system shall be installed where indicated on the plans or specified to be installed. The device shall be capable of being powered by 18VAC, 24VAC, 110VAC or 200VAC to 240VAC without the use of an external transformer. Ionization systems requiring isolation transformers shall not be acceptable.
- b. Ionization Output: The ionization output shall be controlled such that an equal number of positive and negative ions are produced. Imbalanced levels shall not be acceptable. An LED indicator shall be provided to prove ion output is activated.
- c. Ionization output from each electrode shall be a minimum of 200 million ions/cc when tested at 2" from the ionization generator.

6. Ozone Generation:

a. The operation of the electrodes or Bi-polar ionization units shall conform to UL 867-2007 with respect to ozone generation. There shall be no detectable ozone generation during any operating condition, with or without airflow.

7. Electrical Requirements:

- a. Wiring, conduit and junction boxes shall be installed within housing plenums in accordance with NEC NFPA 70. Plasma Generator shall accept an electrical service of 24VAC, 115 VAC or 200-240VAC, 1 phase, 50/60 Hz. The contractor shall coordinate electrical requirements with air purification manufacturer during submittals.
- 8. Control Requirements:

- All Plasma Generators shall have internal short circuit protection, overload protection, and automatic fault reset.
- b. The installing contractor shall mount and wire the Plasma device within the air handling unit specified or as shown or the plans. The contractor shall follow all manufacturer IOM instructions during installation.
- c. A control relay shall be provided to sense the ion output and indicate to the BAS via dry-contacts that the ion output is functioning normally. NO and NC contacts shall be available to the BAS system for ease of integration.
 - Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a Plasma Detector with integral BAS contacts.
 - 2) The Plasma Detector sensor shall be designed to these minimum standards:
 - Ability to detect both positive and negative ion levels from 1,000 ions/cc to 20 million ions/cc minimum. Detection limit shall be field adjustable based on sensor mounting location and manufacturer being sensed.
 - b) Plasma detector shall have integral dry alarm contacts for connection to the BAS to prove the ion system is operating properly and the ion system output is above the minimum preset threshold from the sensor manufacturer. The alarm shall activate when either positive or negative ion output drops below the preset setpoint. Cold plasma systems only providing indication the input power is applied or output power is present shall not be acceptable. The independent cold plasma detector shall be capable of working with any air purification manufacturer's system.
 - Cold plasma detector shall have an input voltage of 12VDC, 24VDC or 24VAC user selectable.
 - d) Cold plasma detector shall be capable of duct mounting or integral air stream mounting.
 - e) Housing shall be constructed of fire retardant ABS plastic.
 - f) Temperature and humidity shall have no effect on the cold plasma detector output accuracy.
 - g) The alarm output shall be provided with NO, NC and C terminals for ease of integration to the BAS. The contacts shall be rated for up to 5 amps at 230VAC or up to 24VDC at 2 amps.
 - h) A BACnet or LonWorks control interface shall be provided by the cold plasma detector manufacturer.
- 9. GPS-IBAR Equipment Requirements (AHU-1):
 - a. Electrode Specifications (Bi-polar Ionization):
 - Each Plasma Generator with Bi-polar Ionization output shall include the required number of electrodes and power generators sized to the air handling equipment capacity. A minimum of sixteen 316 medical grade stainless steel ion needles per foot of coil face width shall be provided. Bi-polar ionization tubes manufactured of glass and steel mesh shall not be acceptable due to replacement requirements, maintenance, and performance output reduction over time, ozone production and corrosion.
 - 2) Electrodes shall be energized when the main unit disconnect is turned on and the fan is operating.

b. Air Handler Mounted Units:

Where so indicated on the plans and/or schedules Plasma Generator(s) shall be supplied and installed. The mechanical contractor shall mount the Plasma Generator and wire it to the remote mount power supply using the high voltage cables provided by the air purification manufacturer. A 115VAC or 230VAC circuit shall be provided to the ion generator power supply panel. Each ion generator shall be designed with an aluminum casing, integral grounding connection and high voltage quick connector.

10. Air Handler Mounted Units:

a. Where so indicated on the plans and/or schedules Plasma Generator(s) shall be supplied and installed. The mechanical contractor shall mount the Plasma Generator and wire it to the remote mount power supply using the high voltage cables provided by the air purification manufacturer. A 115VAC or 230VAC circuit shall be provided to the ion generator power supply panel. Each ion generator shall be designed with an aluminum casing, integral grounding connection and high voltage quick connector.

11. GPS-FC Equipment Requirements (All FCU's):

- Electrode Specifications (Bi-Polar Ionization):
 - 1) Each Plasma Generator with Bi-polar Ionization output shall include the required number of electrodes and power generators sized to the air handling equipment capacity. A minimum of one electrode pair per 1,200 CFM (2,039 m³/h) of air flow shall be provided. Bi-polar ionization tubes manufactured of glass and steel mesh shall not be acceptable due to replacement requirements, maintenance, performance output reduction over time, ozone production and corrosion.
 - 2) Electrodes shall be energized when the main unit disconnect is turned on and the fan is operating. Ionization systems requiring the use of a mechanical air pressure switch to cycle the electrodes only when the fan is operating shall not be acceptable due to high failure rates and pressure sensitivity.

PART 3 - EXECUTION

3.01 TESTS

- A. Refer to Section 230593 "Testing, Adjusting and Balancing" for related requirements.
- B. At his discretion the Owner shall be represented at all tests. Contractor shall provide 48 hours' notice to the Owner prior to the tests unless otherwise specified.
- C. Before insulation is installed and before piping is concealed, test water piping hydrostatically and prove tight under 100 psig pressure. Test pressure shall be held for minimum of 8 hours. An air test in lieu of water may be used when danger of freezing is possible and when approved.
- D. Refrigerant piping shall be tested with dry nitrogen and trace of refrigerant at test pressures recommended by equipment manufacturer. After system has been proven tight under test pressure, it shall be evacuated to a pressure 2.5 mm Hg absolute. The refrigerant compressor shall not be used for evacuating the system. Vacuum shall be checked by use of a mercury manometer.
- E. Coupled pumps shall be field aligned in accordance with the manufacturer's recommended procedures, alignment completed prior to shipment is not acceptable. After the equipment has been aligned, the contractor shall provide a written report verifying that the pumps vertical and horizontal angularity and parallel offset gap are within one of the following tolerances:
 - 1. Pump parallel offset gap shall be within 1/64" at operating speed and pump angularity shall be within 1/64" per inch of coupler radius.

2. The manufacturer's recommended tolerance for the application and with the Engineer's approval.

3.02 WATER TREATMENT

A. Refer to Specification Section 232533 "Water Treatment and Temporary Sub-Micron Filtration Hydronic Systems".

END OF SECTION 230500

SECTION 323119 DECORATIVE METAL FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Decorative steel fences.
- B. Decorative aluminum fences.

1.02 REFERENCE STANDARDS

- A. ASTM A276/A276M Standard Specification for Stainless Steel Bars and Shapes 2017.
- B. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2022.
- C. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
- D. ASTM F2408 Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets 2016 (Reapproved 2023).
- E. CLFMI WLG 2445 Wind Load Guide for the Selection of Line Post and Line Post Spacing 2023.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to start of work of this section; require attendance by affected installers.

1.04 SUBMITTALS

- A. See Section 013000 Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Delegared Design Calculations: Provide calculations for fence panels and accessory selection as well as line post spacing and foundation details. Sizing and engineering of below grade footings, foundations, piers and steel reinforcing of such elements shall be a Delegated Design item providedy by fence manufacturer/installer. Delegated Design engineering shall be project specific.

D. Shop Drawings:

- 1. Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.
- 2. Foundation details, concrete design mix and reinforcing plans for Delegated-Design Foundations.
- E. Samples: Submit two samples of fence panels, for each type of fence specified.
- F. Manufacturer's Installation Instructions: Indicate installation requirements, post foundation anchor bolt templates, and all other Instructions for complete assembly and installation.
- G. Manufacturer's Qualification Statement.
- H. Installer's Qualification Statement.
- I. Manufacturer's Warranty.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- B. Installer Qualifications: Experienced with type of construction involved and materials and techniques specified and approved by fence manufacturer.

1.06 DELIVERY, STORAGE AND HANDLING

A. Store materials in a manner to ensure proper ventilation and drainage. Protect against damage, weather, vandalism and theft.

1.07 WARRANTY

- A. See Section 017800 Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 2 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 FENCES

- A. Fences: Complete factory-fabricated system of posts and panels, accessories, fittings, and fasteners; finished with electrodeposition coating, and having the following performance characteristics:
- B. Electro-Deposition Coating: Multistage pretreatment/wash with zinc phosphate, followed by epoxy primer and acrylic topcoat.
 - 1. Total Coating Thickness: 2 mils, minimum.
- C. Steel: ASTM A653/A653M; tensile strength 45,000 psi, minimum.
 - 1. Hot-dip galvanized; ASTM A653/A653M, G60.
 - 2. 62 percent recycled steel, minimum.
- D. Aluminum: ASTM B221.
 - 1. Tubular Pickets, Rails and Posts: 6005-T5 alloy.
 - 2. Extrusions for Posts and Rails (Outer Channel): 6005-T5 alloy.
 - 3. Extrusions for Pickets and Rail (Inner Slide Channels): 6063-T5 alloy.
- E. Fasteners: ASTM A276/A276M, Type 302 stainless steel; finished to match fence components.
- F. Footings: Below-grade footings, foundations, piers and reinforcing of such elements shall be a Delegated Design item provided by fence manufactur or installer.

2.02 WELDED STEEL FENCE

- A. Provide fence types as show on Drawings.
- B. Fence Panels: Welded steel components, sizes and dimensions as indicated on Drawings
 - 1. Attach panels to posts with manufacturer's standard panel brackets.
- C. Rails: Size and configuration as shown on Drawings
 - 1. Picket Retaining Rods: 0.125 inch galvanized steel.
 - 2. Picket-to-Rail Intersection Seals: PVC grommets.
- D. Pickets: Steel tube.
 - Spacing: 3-3/4 inch clear.
 - 2. Size: As indicated on Drawings
- E. Color: Selected from full range of Manufacturer's colors.

2.03 ALUMINUM FENCE

- A. Decorative Aluminum Fence System: Provide fence meeting the Test Load and Coating Performance requirements of ASTM F2408 for Industrial class.
 - 1. Fence Panels: Size and dimensions indicated on Drawings.
 - a. Panel Style: Fixed Louver Bars providing minimum 80% screening.
 - b. Panel Strength: Capable of supporting 270 pounds minimum load applied at midspan without deflection.
 - c. Attach panels to posts with manufacturer's standard panel brackets and recommended fasteners.
 - d. Posts: Aluminum extrusions; 4 inches square.
 - e. Rails / Louver Frame: Extruded aluminum channels.
 - f. Fixed Louver Bars: Extruded aluminum louver bars, 2" wide nominal, spaced at 2" nominal distance apart.

- g. Cross Bars: 1/2" x 1/8" flat bars welded perpendiculat to back side of louver bars and spaced at 18"
- h. Fasteners: Manufacturer's standard stainless steel bolts, screws, and washers; factory finish fasteners to match fence.
- Accessories: Aluminum castings, extrusions, and cold-formed strips; factory finished to match fence.
- 3. Gates:
 - a. Provide gates of type and size indicated on Drawings. Equip gates with Manufacturer's stdanrd hardware as required for complete functional operation.
 - b. Type: Hinged swinging single and double gates as indicated on the Drawings
 - 1) Construction: Welded frame fabricated from extruded aluminum tubing with aluminum fixed louver panels matching fence panels.
 - c. Color: As selected by Architect from manufacturer's standard range.
 - d. Products:
 - 1) Basis-of-Design: Ametco Manufacturing Corporation, Eclipse Aluminum Fixed Louver Fencing, or equal product as determined by Architect.

2.04 SPECIALITY HARDWARE

- A. Hinges: Finished to match fence components.
 - 1. Closing: Manual.
 - 2. Material: Steel.
 - 3. Provide quantity and configuration of hinges as engineered by Manufacturer for size, dimensions and weigth of gates.
- B. Latches: Finished to match fence components.
 - 1. Mechanism: Gravity.
 - 2. Locking: Mechanical.
 - 3. Material: Steel.
 - 4. Provide hasp for padlock for all gates
 - 5. Provide surface-mounted cremone bolt and pavement insert at bottom of double-gates to secure door in closed positon.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify General Contractor of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Set fence posts in accordance with the manufacturer recommended spacing.

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From Indicated Position: 1 inch.

3.05 FIELD QUALITY CONTROL

- A. See Section 014000 Quality Requirements, for additional requirements.
- B. Gates: Inspect for level, plumb, and alignment.
- C. Workmanship: Verify neat installation free of defects.

3.06 CLEANING

A. Leave immediate work area neat at end of work day.

- B. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.
- C. Clean fence with mild household detergent and clean water rinse well.
- D. Remove mortar from exposed posts and other fencing material using a 10 percent solution of muriatic acid followed immediately by several rinses with clean water.
- E. Touch up scratched surfaces using materials recommended by manufacturer. Match touched-up paint color to factory-applied finish.

3.07 CLOSEOUT ACTIVITIES

A. Demonstrate proper operation of equipment to Owner's designated representative.

3.08 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair, or replace damaged products before Date of Substantial Completion.

END OF SECTION 323119