TOWN OF LEDYARD CONNECTICUT

Permanent Municipal Building Committee

~ AGENDA ~

741 Colonel Ledyard Highway
Ledyard, Connecticut 06339

Chairman
Joseph Gush

Regular Meeting

Monday, September 8, 2025 **5:30 PM** **Town Hall Annex - Hybrid Format**

REMOTE MEETING INFORMATION

Join Zoom Meeting
https://us06web.zoom.us/launch/edl?muid=c8d78459-cdcd-4855-86f1-9366fcc92009
Meeting ID: 845 4506 8864 Passcode: 047672
One tap mobile +13092053325,,84545068864#,,,,*047672# US

I. CALL TO ORDER

II. ROLL CALL

III. RESIDENTS & PROPERTY OWNERS COMMENTS

IV. APPROVAL OF MINUTES

1. MOTION to approve the PMBC Regular Meeting Minutes of August 4, 2025.

   Attachments: PMBC Regular Meeting Minutes 8.4.2025

V. UPDATE ON JULIET LONG, GALES FERRY ADN BOE CENTRAL OFFICE PROJECTS

1. Update/Discussion on Roof Projects & Budget Documents

   Attachments: Ledyard Roof Project Budget 2025.05.28

2. MOTION to approve Shipman & Goodwin LLP Inv # 667681 dated 8.19.2025 in the amount of $1,534.00 for Professional Services Rendered.

3. MOTION to amend the amount due from $1534.00 to $1062.00 for the MOTION to approve Shipman & Goodwin LLP Inv #665973 dated 7.14.2025 in the amount of $1,534.00 for Professional Services Rendered approved on August 4, 2025.

VI. JULIET LONG HVAC PROJECT UPDATES

1. JWL HVAC Project 2024 Updates

Attachments: HVAC Scope 07-10-2024
00-TOC
221111 - FACILITY NATURAL GAS PIPING
230130.51 - HVAC AIR DISTRIBUTION SYSTEM CLEANING
230500 - COMMON WORK RESULTS FOR MECHANICAL
230510 - PROJECT COORDINATION AND COORDINATION DRAWINGS
230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING AND DUCTWORK
230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
230593 - TESTING, ADJUSTING AND BALANCING FOR HVAC
230713 - DUCT INSULATION
230719 - HVAC PIPING INSULATION
230800 - COMMISSIONING OF HVAC
230940 - HVAC INSTRUMENTATION AND CONTROLS
232300 - REFRIGERANT PIPING
233113 - METAL DUCTS
233300 - AIR DUCT ACCESSORIES
233713 - DIFFUSERS, REGISTERS, AND GRILLES
237200 - AIR-TO-AIR ENERGY RECOVERY EQUIPMENT
237413 - OUTDOOR CENTRAL STATION AIR HANDLING UNITS
238125 - VARIABLE REFRIGERANT VOLUME (VRV) AIRCONDITIONING SYSTEM
Juliet Long Drawing Set
PMBC Letter to Town Council re_increase apprpriate JWL HVAC 4.7.2025
Project Budget 2025-03-31 Friar updated

2. JWL HVAC Owner's Project Management Report - Colliers

   Attachments: Contingency Status Report Colliers JWL HVAC 9.5.2025
   Financial Status Report Colliers JWL HVAC 9.5.2025

3. MOTION to approve Collier Project Leaders Inv #0001078589 dated 7.31.2025 in the amount of $5,430.00 for Project 24012605G OPM-Juliet Long HVAC Installation.

   Attachments: Ledyard CT, Town of 24012605G - 0001078589

4. MOTION to approve Colliers Project Inv #0001088123 dated 8.31.2025 in the amount of $10,844.90 for Project 24012605G OPM-Juliet Long HVAC Installation.

   Attachments: Ledyard CT 24012605G - 0001088123

5. MOTION to approve Kamco Supply Corp of New England Inv #2507-066308 dated

7.22.2025 in the amount of $1,298.00 for Order #2507-E64543 JWL-HVAC Project.

Attachments: Kamco Inv2507_066308 7.22.2025 JWL HVAC

6. MOTION to approve Kamco Supply Corp of New England Inv #2507-072778 dated 7.29.2025 in the amount of $406.00 for Order #2507-E71735 JWL-HVAC Project.

   Attachments: Kamco Inv2507_072778 7.29.2025

7. MOTION to approve Kamco Supply Corp of New England Inv #2508-099062 dated 8.28.2025 in the amount of $58.00 for Order: 2508-E90923 JWL – HVAC Project.

   Attachments: Kamco Inv2508-099062 8.28.2025

8. MOTION to approve The Nutmeg Companies, Inc. Application for Payment dated 8.27.2025 in the amount of $485,496.55 for Project 2503 Juliet W. Long Elementary School HVAC Replacement.

   Attachments: Invoice02_2503_Juliet_Long_Aug2025 (FA)

9. Approval of RFP for Commissioning Agent services.

VII. OLD BUSINESS

1. Any Old Business proper to come before the Committee

VIII. NEW BUSINESS

1. Any New Business proper to come before the Committee

IX. ADJOURNMENT

DISCLAIMER: Although we try to be timely and accurate these are not official records of the Town.

File #: 25-2442 **Agenda Date:** 9/8/2025 **Agenda #:** 1.

MINUTES

Minutes:
MOTION to approve the PMBC Regular Meeting Minutes of August 4, 2025.

TOWN OF LEDYARD

Permanent Municipal Building Committee

Meeting Minutes - Draft Minutes

741 Colonel Ledyard Highway
Ledyard, Connecticut 06339

Chairman
Joseph Gush

Regular Meeting

Monday, August 4, 2025 **5:30 PM** **Town Hall Annex - Hybrid Format**

REMOTE MEETING INFORMATION

Join Zoom Meeting
https://us06web.zoom.us/j/84145731926?pwd=RL93VlEcF8blkaa5m2i1tX5KxOwElg.1
Meeting ID: 841 4573 1926 Passcode: 033670 • +1 646 558 8656 US (New York)

I. CALL TO ORDER

Chairman Gush called the meeting to order at 5:30 p.m. at the Council Chambers, Town Hall Annex Building.

II. ROLL CALL

Present Committee Member Gary Schneider
Committee Member Gerald Tyminski
Chairperson Joseph Gush
Committee Member George Hosey
BOE Representative Kate DiPalma-Herb
Absent BOE Representative Jennifer Reguin

In addition, the following were present:
Mathew Bonin - Finance Director
Kristen Chapman - PMBC Support Staff
Wayne Donaldson - BOE Facilities Director
Mark Dupre - STV
Scott Mitchell - Friar Architecture
Vincent Salinas - STV
Charles Warrington - Colliers Project Leaders

III. RESIDENTS & PROPERTY OWNERS COMMENTS

None

IV. APPROVAL OF MINUTES

1. MOTION to approve the PMBC Special Meeting/Executive Session Minutes of July 7, 2025 and the PMBC Regular Meeting Minutes of July 7, 2025.

RESULT: APPROVED AND SO DECLARED
MOVER: Gerald Tyminski
SECONDER: Gary Schneider

AYE	4	Schneider Tyminski Gush Hosey
ABSENT	1	Reguin
NON-VOTING	1	DiPalma-Herb

V. UPDATE ON JULIET LONG, GALES FERRY AND BOE CENTRAL OFFICE PROJECTS

1. Update/Discussion on Roof Projects & Budget Documents

Mr. Donaldson reported there has been no change on the roof projects at BOE Central Office or Gales Ferry School since the last meeting. Mr. Donaldson added the committee is still awaiting information discussed in the executive session. Mr. Donaldson stated he is still awaiting for the contractor to confirm with the architect that the roof is complete and receive a final punch list.

Mr. Donaldson reported that Juliet Long School has been done for quite a while with the exception of the walk pads. The wiring for the solar is complete and they are still waiting on delivery of the switch gear, hopefully it will be switched over before school starts.

Chairman Gush inquired if the budget sheet given is what Mr. Bonin has requested. Mr. Donaldson replied that there has been no change to the budget document since the last meeting. STV has been instructed to not send anything over that has not been approved by Mr. Bonin.

2. MOTION to recommend Mayor Fred B. Allyn III execute "Standard Fast Track and Study Process Generator Interconnection Agreement" and "Contingent Approval for INT-109249" between The Connecticut Light and Power Company d/b/a Eversource Energy for INT-109249 - Juliet Long School_Ledyard Board of Education.

In addition, authorize payment of $1972.00 to Eversource Energy for Metter Cost - INT-109249 - Juliet Long Elementary School_Ledyard Board of Education - Netting Non-Residential (NRES) - 165.6kW.

Discussion:
Mr. Donaldson explained this is Interconnect Agreement for the solar that allows us to tie into Eversource's system. This was forwarded from the electrician working on the project and is awaiting the town's signature. Mr. Tymniski inquired if we would get anything back if we generate backwards? Mr. Donaldson replied, this is only covering 40%, in the summer if it is overcompensating and when the air conditioning kicks in on a hotter day we will get that back.

RESULT: APPROVED AND SO DECLARED
MOVER: Gerald Tyminski

SECONDER: Kate DiPalma-Herb

AYE 5 Schneider Tyminski Gush Hosey DiPalma-Herb

ABSENT 1 Reguin

3. MOTION to amend the amount due to $1062.00 for the MOTION to approve Shipman & Goodwin LLP Inv #665973 dated 7.14.2025 in the amount of $1,534.00 for Professional Services Rendered.

Mr. Donaldson stated this is for the work being discussed in executive session

RESULT: APPROVED AND SO DECLARED
MOVER: Gerald Tyminski
SECONDER: Kate DiPalma-Herb

AYE 5 Schneider Tyminski Gush Hosey DiPalma-Herb

ABSENT 1 Reguin

4. MOTION to approve Shipman & Goodwin LLP Inv# 665974 dated 7.14.2025 in the amount of $2,861.50 for Professional Services Rendered.

RESULT: APPROVED AND SO DECLARED
MOVER: Gerald Tyminski
SECONDER: Kate DiPalma-Herb

AYE 5 Schneider Tyminski Gush Hosey DiPalma-Herb

ABSENT 1 Reguin

VI. STV & SILVER PETRUCELLI & ASSOCIATES UPDATE OF ROOF AND SOLAR PROJECTS

1. MOTION to approve STV Inv #90034678 dated 6.11.2025 in the amount of $12,231.00 for Project 212247 Ledyard Schools Central Office.

Mr. Donaldson stated this is the amendment to the contract for additional work due to the delays with Imperial. Mr. Tyminski questioned why they just list the tasks and hours and no dollars. Mr. Donaldson stated that was questioned by Mr. Bonin and he believes that was worked out and acceptable to Mr. Bonin. Mr. Donaldson added it was a lump sum originally and then broken out by the hours. Mr. Tyminksi questioned Mr. Bonin not having an issue as the invoice does seem strange. Mr. Salinas added the invoicing submitted for both Juliet Long, Gales Ferry and BOE included all of the backup that we have been submitting for this project from the beginning. Mr. Tyminiski stated there are no dollar associated with those hours. Mr. Salinas stated backup was submitted as it has been in the past. One sheet should have the breakdown of all the hours, the contract information and backup of all the hours worked throughout that time period. Mr. Schneider added the summary sheet does not match what is being submitted for invoices, minor but needs to be corrected. Mr. Salinas will make those corrections.

RESULT: APPROVED AND SO DECLARED
MOVER: Gary Schneider

SECONDER: Kate DiPalma-Herb

AYE 5 Schneider Tyminski Gush Hosey DiPalma-Herb

ABSENT 1 Reguin

2. MOTION to approve STV Inv #90034680 dated 6.11.2025 in the amount of $10,200.80 for Project 212247 Ledyard Schools Juliet Long School.

RESULT: APPROVED AND SO DECLARED
MOVER: Gerald Tyminski
SECONDER: Kate DiPalma-Herb

AYE 5 Schneider Tyminski Gush Hosey DiPalma-Herb

ABSENT 1 Reguin

3. MOTION to approve STV Inv# 90034679 dated 6.11.2025 in the amount of $31,916.75 for Project 212247 Ledyard Schools Gales Ferry School.

RESULT: APPROVED AND SO DECLARED
MOVER: Gerald Tyminski
SECONDER: Kate DiPalma-Herb

AYE 5 Schneider Tyminski Gush Hosey DiPalma-Herb

ABSENT 1 Reguin

VII. JULIET LONG HVAC PROJECT UPDATES

1. JWL HVAC Project 2024 Updates

Mr. Donaldson provided an update on the JWL HVAC project. Chairman Gush informed the Committee that there is an issue with the cable run in the tunnel. Mr. Donaldson original design was to run the piping in the ceiling to the custodial room and then run in the ceiling across to the other side of the school to the other custodial room. It was determined that the piping could not run through the ceiling due to steel beams preventing that path. Mr. Donaldson shared another option was to run through the roof and across the roof which he as not keen on for a number of reasons and suggested running through the tunnel. The electrician was happy to do that and needed a design. The design came back significantly different than the original design. Mr. Donaldson stated a new design and a quote should be available shortly. Mr. Donaldson will come back to the committee with a change order. Chairman Gush stated all of the vent ducting is in for the supply area. Mr. Donaldson shared all the ducting for the make up air is in and most of the classroom units have been hung as well as the soffit work and sheet rock. Mr. Donaldson stated there are three room with unique features, the kitchen, room 5A and the last LTA room. The LTA (Ledyard Transition Academy) has three room in the school with their own entrance. Mr. Donaldson invited the committee members to tour the building.

The committee discussed work that will still need to take place during school and after hours. Mr. Schneider inquired if Mr. Donaldson was confident that the Building Official would issue a temporary Certificate of Occupancy. Mr. Donaldson replied as long as all the fire ducts and

smoke ducts are sealed there should not be an issue.

2. JWL HVAC Owner's Project Management Report - Colliers

Mr. Warrington stated the contract was signed with Colliers on July 15 and they have begun engaging in the field and attending meetings. took a look at the tunnel himself as it is a confined space and wants to make sure everyone is safe. Mr. Warrington sated he looked at the documents and the bid was to install in the ceiling and the steel ductwork only allows 16-18 inches above ceiling to the bottom of the roof deck and there are some steal beams that are pretty deep only allowing 2-4 inches of space to get through. Mr. Warrington added it will be more labor intensive to go through the basement. Mr. Warrington shared a photo of the tunnel with the committee and discussed the process to run through the tunnel. Mr. Warrington expects the cost to be more expensive due to the labor required. Mr. Warrington agrees with the recommendation to go through the tunnel from a long term perspective. Mr. Warrington shared a photo of the work being done in a typical classroom and shared specifics of the work taking place. Mr. Warrington will notify Mr. Donaldson when inspections take place.

Mr. Warrington presented the "Financial Status Report" and discussed the line items that will be utilized for this project. Mr. Warrington discussed the projected contingency for the project, stating that there should be savings on this project. Mr. Warrington reviewed the "Contingency Status Report" (change order log) with the committee and the two change orders presented to date.

Mr. Schneider inquired on the status of the contract with Nutmeg now that the referendum has passed. Mr. Donaldson and Mr.MItchell explained that Friar did not sign the first contract with items removed, that contract was void and the contract reverted to the original bid amount and has been executed by the Mayor. Reverting back to the original contract clarifies the process as the project has been funded through Referendum.

Mr. Mitchell stated Nutmeg is proceeding well and made up quite a bit of the schedule due to the late signing of the contract.

3. MOTION to approve AIA Document G701-2017 Change Order Number 001 dated 7.23.2025 in the amount of ($200,514.00) for Project 2023-121A Juliet W. Long School - HVAC.

Discussion:
Chairman Gush shared these are contingency funds moving out of the contractor bucket and putting it back with the town.

RESULT: APPROVED AND SO DECLARED
MOVER: Gerald Tyminski
SECONDER: Kate DiPalma-Herb

AYE 5 Schneider Tyminski Gush Hosey DiPalma-Herb

ABSENT 1 Reguin

4. MOTION to approve Materials Testing, Inc. Proposal No. S-072516833 dated 7.30.2025 not to exceed $2,500.00 for Ledyard Juliet Long HVAC Installation Project - DAS State Contract 19PSX0223.

Discussion:
Mr. Warrington clarified this is the state DAS contract that all towns and municipalities can use in lieu of bidding in addition to this amount being well under the bid threshold. Mr. Tyminski questioned if this was for the steel testing? Mr. Warrington replied yes this is inspection of the framing for rooftop units.

RESULT: APPROVED AND SO DECLARED
MOVER: Gerald Tyminski
SECONDER: Kate DiPalma-Herb

AYE 5 Schneider Tyminski Gush Hosey DiPalma-Herb

ABSENT 1 Reguin

5. MOTION to approve The Nutmeg Companies, Inc. Application for Payment dated 7.29.2025 in the amount of $791,024.15 for Project 2503 Juliet W. Long Elementary School HVAC Replacement.

RESULT: APPROVED AND SO DECLARED
MOVER: Gerald Tyminski
SECONDER: Kate DiPalma-Herb

AYE 5 Schneider Tyminski Gush Hosey DiPalma-Herb

ABSENT 1 Reguin

****ADD ON****

6. MOTION to approve Friar Architecture Inc. Inv #2023-121A-08 dated 7.31.2025 in the amount of $4,200.00 for Project 2023-121A Ledyard - Juliet Long HVAC.

RESULT: APPROVED AND SO DECLARED
MOVER: Gerald Tyminski
SECONDER: Kate DiPalma-Herb

AYE 5 Schneider Tyminski Gush Hosey DiPalma-Herb

ABSENT 1 Reguin

7. MOTION to approve up to $50,000 for soffit and ceiling installation for JWL HVAC Project.

Discussion:
Mr. Donaldson stated metal stud wall that comes down 12 inches to install ceiling tiles to hid the duct work.

RESULT: APPROVED AND SO DECLARED
MOVER: Gerald Tyminski
SECONDER: Kate DiPalma-Herb

AYE 5 Schneider Tyminski Gush Hosey DiPalma-Herb

ABSENT 1 Reguin

VIII. OLD BUSINESS

1. Discussion and possible action regarding furniture for the Gallup Hill School Building Project.

Chairman Gush inquired if we had contacted the vendor to negotiate the price for what we would not have covered through grants. Mr. Donaldson stated that we have contacted the vendor advised them that we would offer the amount we would have paid less the grant. Mr. Donaldson added they rejected that and suggested they make a counteroffer. Mr. Tyminiski stated supposedly we received that but there is no documentation that we made payment but it's five years old and we are assuming we would have already paid. Mr. Donaldson was able to confirm that everything except the bulleting boards were delivered but has no way to verify the number of bulletin boards is accurate. Mr. Donaldson added that as far as Mr. Bonin knows we did not pay for it. Mr. Tyminski stated all of those invoices would have come before the committee years ago, it seems that they were never invoiced and it was never incorporated. The committee further discussed the offer to pay 38%. Mr. Donaldson added he would like to have an agreement that states the amount is accepted. Chairman Gush requested this item be removed from the agenda until there is an update.

2. Any Old Business proper to come before the Committee

None

IX. NEW BUSINESS

1. Any New Business proper to come before the Committee

None

X. ADJOURNMENT

Mr. Tyminski moved the meeting be adjourned, seconded by Mr. Schneider.

The meeting adjourned at 6:43 p.m.
VOTE: 4-0 Approved and so declared

Respectively Submitted,

_____
Chairman Gush
Permanent Municipal Building Commitee

DISCLAIMER: Although we try to be timely and accurate these are not official records of the Town.

File #: 24-0620 **Agenda Date:** 9/8/2025 **Agenda #:** 1.

AGENDA REQUEST
GENERAL DISCUSSION ITEM

Subject:
Update/Discussion on Roof Projects & Budget Documents

Background:
(type text here)

Department Comment/Recommendation:
(type text here)

BUDGET TRACKING REPORT

Ledyard Roof Project Date:May 28, 2025	Total Project	Funding	Contracted	Unallocated Funding	Invoiced to Date	Remaining to Invoice
		$6,167,827	**$5,963,135**	**$204,692**	**$4,421,133**	**$1,542,001**
Individual Projects	Gales Ferry	$2,684,441	$2,782,928	($98,487)	$1,897,809	$885,120
	Juliet W Long	$3,020,186	$2,725,484	$294,702	$2,164,093	$561,391
	BOE	$463,200	$454,723	$8,477	$359,231	$95,491

	ITEM DESCRIPTION	Base	Change Orders	Total	Invoiced to Date BOE	Invoiced to Date Gales Ferry	Invoiced to Date Juliet W Long	Remaining to Invoice
SUMMARY	**Current Project Total**	**$5,571,680**	**$391,455**	**$5,963,135**	**$359,231**	**$1,897,809**	**$2,164,093**	**$1,542,001**
	Construction Total	$5,280,500	$288,465	$5,568,965	$321,780	$1,761,557	$2,030,638	$1,454,989
	Professional Fees	$172,712	$102,990	$275,702	$26,395	$92,393	$69,902	$87,012
	Various Fees	$118,468	$0	$118,468	$11,057	$43,858	$63,553	$0
GC	**Construction Total**	**$5,280,500**	**$288,465**	**$5,568,965**	**$321,780**	**$1,761,557**	**$2,030,638**	**$1,454,989**
	Imperial (Gales Ferry)	$2,585,500	$15,471	$2,600,971		$1,761,557		$839,414
	Gold Seal (Juliet Long)	$2,317,000	$252,482	$2,569,482			$2,030,638	$538,844
	Imperial (BOE)	$378,000	$20,512	$398,512	$321,780			$76,732
PF	**Professional Fees**	**$172,712**	**$102,990**	**$275,702**	**$26,395**	**$92,393**	**$69,902**	**$87,012**
	STV (Gales Ferry)	$39,482	$57,117	$96,599		$42,708		$53,891
	STV (Juliet Long)	$39,482	$21,437	$60,919			$38,876	$22,043
	STV (BOE)	$15,468	$15,086	$30,554	$13,641			$16,913
	Silver Petrucelli (Gales Ferry)	$33,000	$8,500	$41,500		$49,685		($8,185)
	Silver Petrucelli (Juliet Long)	$31,530	$0	$31,530			$31,026	$504
	Silver Petrucelli (BOE)	$13,750	$850	$14,600	$12,754			$1,846
VF	**Various Fees**	**$118,468**	**$0**	**$118,468**	**$11,057**	**$43,858**	**$63,553**	**$0**
	Gales Ferry	$19,932	$0	$19,932	$0	$19,932	$0	$0
	Juliet Long	$33,646	$0	$33,646	$0	$0	$33,646	$0
	BOE	$5,075	$0	$5,075	$5,075	$0	$0	$0
	Interest Expense	$3,825	$0	$3,825	$383	$1,530	$1,913	$0
	Borrowing	$55,990	$0	$55,990	$5,599	$22,396	$27,995	$0

File #: 25-2438 **Agenda Date:** 9/8/2025 **Agenda #:** 2.

FINANCIAL BUSINESS REQUEST (FBR)

Motion/Request:
MOTION to approve Shipman & Goodwin LLP Inv # 667681 dated 8.19.2025 in the amount of $1,534.00 for Professional Services Rendered.

Background:
(type text here)

Department Comment/Recommendation:
(type text here)

Finance Director Comment/Recommendation:
(type text here)

Mayor Comment/Recommendation:
(type text here)

File #: 25-2280 **Agenda Date:** 8/4/2025 **Agenda #:** 3.

FINANCIAL BUSINESS REQUEST (FBR)

Motion/Request:
MOTION to amend the amount due from $1534.00 to $1062.00 for the MOTION to approve Shipman & Goodwin LLP Inv #665973 dated 7.14.2025 in the amount of $1,534.00 for Professional Services Rendered approved on August 4, 2025.

Background:
(type text here)

Department Comment/Recommendation:
(type text here)

Finance Director Comment/Recommendation:
(type text here)

Mayor Comment/Recommendation:
(type text here)

File #: 24-0577 **Agenda Date:** 9/8/2025 **Agenda #:** 1.

AGENDA REQUEST
GENERAL DISCUSSION ITEM

Subject:
JWL HVAC Project 2024 Updates

Background:
(type text here)

Department Comment/Recommendation:
(type text here)

Juliet W. Long School – HVAC Upgrades Project Scope
July 10, 2024

Existing Conditions:

1. The school is made up of two classroom wings, a Gymnasium (used as Cafeteria) and a small office area.
2. The classroom areas are currently ventilated with operable windows and heated with hot water finned tube radiation.
3. The Gymnasium is ventilated and heated with floor mounted unit ventilators.
4. An exhaust fan and louver in the Gymnasium is used for fresh air ventilation.
5. The Office area is heated and cooled with a gas fired packaged rooftop air conditioning unit.
6. Building hot water is generated by two gas-fired boilers located in basement mechanical room.

HVAC Improvements:

1. Classrooms will be ventilated with two roof mounted DOA (Dedicated Outdoor Air) units with gas-heating, DX (Direct Expansion) Cooling and Heat recovery, located on the roof.
2. Roof mounted insulated supply ductwork will drop down into new ceiling soffit area to serve the room with fresh air.
3. Classroom exhaust air will drop into basement tunnel and once manifolded, will rise into the DOA units.
4. Classrooms will be heated and cooled with new VRF (Variable Refrigerant Flow) heat pumps. The Hot water fin tube radiation will remain for supplemental heating when outdoor temps are below 40F.
5. New classroom ceiling soffits will be located from the corridor wall to first exposed steel beam and will contain the VRF fan coil units and ductwork in a dropped ceiling cavity.
6. Existing restrooms are currently exhausted by roof mounted exhaust fans. Existing fans will be removed and DOA unit will exhaust via roof mounted ductwork. Energy will be recovered from the restroom exhaust via a rotary heat exchanger (enthalpy wheel) located in the DOA unit.
7. The Gymnasium will be heated, cooled and ventilated with new gas-fired packaged DX RTU (Rooftop Unit).
8. The Office area RTU will be replaced with new gas-fired packaged DX RTU.
9. New RTUs will be equipped with demand control ventilation which adjusts fresh air to spaces based on occupancy and reduces energy cost.
10. New RTUs will be equipped with HGRH (Hot Gas Reheat) for improved dehumidification control.
11. All existing Pneumatic controls shall be replaced with new digital controls. All new controls shall be BacNet and will tie into new DDC (Direct Digital Control) system.

Other:

1. Electrical work including powering of all new equipment and new lighting in classroom soffits.
2. Architectural work including ceilings, miscellaneous roof work and penetrations.
3. Minor structural work to support new mechanical equipment.

LEDYARD PUBLIC SCHOOLS - HVAC REPLACEMENT
JULIETE W. LONG ELEMENTARY SCHOOL
1854 CT-12, GALES FERRY, CT 06335

END OF TABLE OF CONTENTS

TABLE OF CONTENTS
SECTION 221111 – FACILITY NATURAL-GAS PIPING

SECTION 221111 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Service meters.
7. Concrete bases.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 125 psig minimum unless otherwise indicated.
2. Service Regulators: 65 psig minimum unless otherwise indicated.
3. Minimum Operating Pressure of Service Meter: 5 psig.

B. Natural-Gas System Pressure within Buildings: 0.5 psig or less.

C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.
2. Corrugated, stainless-steel tubing with associated components.
3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Service meters. Indicate[pressure ratings and] capacities. Include [bypass fittings and meter bars] and [supports].
6. Dielectric fittings.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot.
2. Detail mounting, supports, and valve arrangements for [**service meter assembly and**] pressure regulator assembly.

C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

D. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

E. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

F. Qualification Data: For qualified professional engineer.

G. Welding certificates.

H. Field quality-control reports.

I. Operation and Maintenance Data: For [**motorized gas valves**] [**pressure regulators**] [**and**] [**service meters**] to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify Owner no fewer than five days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Not permitted underground.
    d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

6. Mechanical Couplings:

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) Dresser Piping Specialties; Division of Dresser, Inc.
        2) Smith-Blair, Inc.

    b. [**Stainless-steel**] flanges and tube with epoxy finish.
    c. Buna-nitrile seals.
    d. [**Stainless-steel**] bolts, washers, and nuts.

e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

B. Corrugated, Stainless-Steel Tubing for Final Connections to Equipment and Appliances Only: Comply with ANSI/IAS LC 1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following :

a. OmegaFlex, Inc.
b. Parker Hannifin Corporation; Parflex Division.
c. Titeflex.
d. Tru-Flex Metal Hose Corp.

2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
3. Coating: PE with flame retardant.

a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1) Flame-Spread Index: 25 or less.
2) Smoke-Developed Index: 50 or less.

4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
5. Striker Plates: Steel, designed to protect tubing from penetrations.
6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
7. Operating-Pressure Rating: 5 psig.

C. Annealed-Temper Copper Tube: Comply with [ASTM B 88, Type K].

1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
2. Flare Fittings: Comply with ASME B16.26 and SAE J513.

a. Copper fittings with long nuts.
b. Metal-to-metal compression seal without gasket.
c. Dryseal threads complying with ASME B1.20.3.

3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch thick.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.

C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. NIBCO Model T-585-70 or T-FP-600A

   b. BrassCraft Manufacturing Company; a Masco company.
   c. Conbraco Industries, Inc.; Apollo Div.
   d. Lyall, R. W. & Company, Inc.
   e. McDonald, A. Y. Mfg. Co.
   f. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service.

E. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Lee Brass Company.
   b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service.

2.5 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Actaris.
    b. American Meter Company.
    c. Eclipse Combustion, Inc.
    d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
    e. Invensys.
    f. Maxitrol Company.
    g. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 2 psig.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Eaton Corporation; Controls Div.
    b. Harper Wyman Co.
    c. Maxitrol Company.
    d. SCP, Inc.

2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 1 psig.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Matco-Norca, Inc.
    b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    c. Wilkins; a Zurn company.

2. Description:

    a. Standard: ASSE 1079.
    b. Factory-fabricated, bolted, companion-flange assembly.
    c. Pressure Rating: 125 psig minimum at 180 deg F.
    d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

C. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Advance Products & Systems, Inc.

b. Calpico, Inc.
c. Pipeline Seal and Insulator, Inc.

2. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to [NFPA 54] to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with [NFPA 54] requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least [36 inches] below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.

D. Copper Tubing with Protective Coating:

1. Apply joint cover kits over tubing to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

E. Install fittings for changes in direction and branch connections.

F. Install pressure gage downstream from each service regulator. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping."

3.4 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

3.5 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

3.6 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hangers and supports specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

3.7 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.8 LABELING AND IDENTIFYING

A. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.9 PAINTING

A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel [**(flat)**].
d. Color: [**Gray**].

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 FIELD QUALITY CONTROL

A. Inspect, test, and purge piping according to ANSI Z223.1, Part 4 "Inspection, Testing, and Purging," and requirements of authorities having jurisdiction.

B. irements of authorities having jurisdiction.

C. isdiction.

1. Horizontal runs shall be level or pitched slightly to dirt leg.
2. Branch piping shall be taken off from top of mains. Provide dirt leg at bottom of each piping drop to boiler, heaters, and other gas-burning equipment.
3. Gas piping exterior to building and exposed to weather (e.g., service piping at meter) shall have zinc-rich primer and two coats of VOC-compliant epoxy. (VOC = Volatile Organic Compounds.)
4. Mount gas emergency off switches and pushbuttons at handicapped heights.
5. Provide lubricated plug valve on service entrance pipe located at meter. Provide red lamicoid label adjacent to valve, to read:

EMERGENCY SHUTOFF VALVE

6. Gas Pipe Testing and Purging Procedures

a. Pressure Testing: The building piping shall be pressure tested in accordance with the National Fuel Gas Code (NFPA-54). The test medium shall be nitrogen (N_2),

carbon dioxide (CO_2) or air. The local authority having jurisdiction and the Local Gas Distribution Company (LDC) must approve the test pressure and duration.

b. Purging and Placing Gas Piping into Operation: Upon notification and meter being turned on by Local Distribution Gas Company, the house line can be placed in operation. All purging shall be done in accordance with NFPA-54.

1) The air can be safely displaced with natural gas provided that a moderately rapid and continuous flow of gas is introduced at the meter and air is vented to the outside of the building by means of connecting a rigid pipe or a semi-rigid metallic tubing with appropriate fittings.
2) The purge piping must be located outside of the building at a safe distance away from fresh air intakes and away from any sources of ignition. The end of the purge riser must be equipped with a flash back arrester. The purge riser must be manned at all times. A fire extinguisher must be placed nearby while purging is in operation. A combustible gas indicator (CGI) can be used to assure the house line is purged properly to 100% gas.
3) must be manned at all times. A fire extinguisher must be placed nearby while purging is in operation. A combustible gas indicator (CGI) can be used to assure the house line is purged properly to 100% gas.
4) In the event of multi-floor house lines, the longest house line (furthest from the meter) must be purged first, followed by the next longest, until all sections of house lines have been purged to 100% gas.

c. Odorant Level: All house lines must be continuously purged until such a time that the odorant level is sufficiently detectable by smell and confirmed with an odorant level instrument such as a Bacharach Model 5110-200, or equivalent. The instrument shall have a range of 0 to 1.2% gas in air. The line must be purged until a readily detectable odorant reading of 0.25% or less gas in air is maintained.

1) As soon as the acceptable odorant level reading is maintained at all purging locations, turn off the ends of house lines, disconnect the purging tubing, permanently plug all ends and leak test all plugs. Gas utilization equipment can now be purged and placed into operation.
2) f house lines, disconnect the purging tubing, permanently plug all ends and leak test all plugs. Gas utilization equipment can now be purged and placed into operation.
3) Odorant level readings shall be re-taken periodically to ensure proper level of odorant is maintained. Odorant level may decay especially in low flow house lines. If this occurs, purging procedures must be repeated as needed.

D. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

E. Report test results promptly and in writing to Architect and authorities having jurisdiction.

F. Verify capacities and pressure ratings of valves, and specialties.

G. Verify correct pressure settings for pressure regulators.

H. Verify that specified piping tests are complete.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.12 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be[**one of**] the following:

1. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
2. [**Annealed**]-temper copper tube with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

B. Aboveground natural-gas piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.13 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:

1. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be the following:

1. Cast-iron, nonlubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be the following:

1. Cast-iron, lubricated plug valve.

E. Valves in branch piping for single appliance shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 221111

TABLE OF CONTENTS
SECTION 230130.51 – HVAC AIR-DISTRIBUTION SYSTEM CLEANING

SECTION 230130.51 - HVAC AIR-DISTRIBUTION SYSTEM CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes cleaning HVAC air-distribution equipment, ducts, plenums, and system components.

1.3 DEFINITIONS

A. ASCS: Air systems cleaning specialist.

B. NADCA: National Air Duct Cleaners Association.

1.4 SUBMITTALS

A. Qualification Data: For an ASCS.

B. Strategies and procedures plan.

C. Cleanliness verification report.

1.5 QUALITY ASSURANCE

A. ASCS Qualifications: A certified member of NADCA.

1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
2. Supervisor Qualifications: Certified as an ASCS by NADCA.

B. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.

C. Cleaning Conference: Conduct conference at Project site.

1. Review methods and procedures related to HVAC air-distribution system cleaning including, but not limited to, review of the cleaning strategies and procedures plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.

B. Perform "Project Evaluation and Recommendation" according to NADCA ACR 2006.

C. Prepare written report listing conditions detrimental to performance of the Work.

D. Proceed with work only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare a written plan that includes strategies and step-by-step procedures. At a minimum, include the following:

1. Supervisor contact information.
2. Work schedule including location, times, and impact on occupied areas.
3. Methods and materials planned for each HVAC component type.
4. Required support from other trades.
5. Equipment and material storage requirements.
6. Exhaust equipment setup locations.

B. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.

C. Comply with NADCA ACR 2006, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

3.3 CLEANING

A. Comply with NADCA ACR 2006.

B. Remove visible surface contaminants and deposits from within the HVAC system.

C. Systems and Components to Be Cleaned:

1. Air devices for supply and return air.
2. Air-terminal units.
3. Ductwork:

a. Supply-air ducts, including turning vanes to the air-handling unit.
b. Return-air ducts to the air-handling unit.
c. Exhaust-air ducts.

4. Filters and filter housings.

D. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.

E. Particulate Collection:

1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,

F. Control odors and mist vapors during the cleaning and restoration process.

G. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.

H. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.

I. Clean all air-distribution devices, registers, grilles, and diffusers.

J. Duct Systems:

1. Create service openings in the HVAC system as necessary to accommodate cleaning.
2. Mechanically clean duct systems specified to remove all visible contaminants so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).

K. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.

L. Mechanical Cleaning Methodology:

1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.

a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials such as duct and plenum liners.

3.4 CLEANLINESS VERIFICATION

A. Verify cleanliness according to NADCA ACR 2006, "Verification of HVAC System Cleanliness" Section.

B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.

C. Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.

D. Additional Verification:

1. Perform surface comparison testing or NADCA vacuum test.
2. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.

E. Prepare a written cleanliness verification report. At a minimum, include the following:

1. Written documentation of the success of the cleaning.
2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
3. Surface comparison test results if required.
4. Gravimetric analysis (nonporous surfaces only).
5. System areas found to be damaged.

F. Photographic Documentation: Comply with requirements in Division 01 Section "Photographic Documentation."

3.5 RESTORATION

A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR 2006, "Restoration and Repair of Mechanical Systems" Section.

B. Restore service openings capable of future reopening. Comply with requirements in Division 23 Section "Metal Ducts." Include location of service openings in Project closeout report.

C. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Division 23 Sections "Metal Ducts" and "Nonmetal Ducts."

D. Replace damaged insulation according to "Division 23 Section "HVAC Insulation."

E. Ensure that closures do not hinder or alter airflow.

F. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.

END OF SECTION 230130.51

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PART 1 - GENERAL

1.1 REFERENCES

A. Refer to the GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS and applicable parts of DIVISION 1 for other general requirements. These requirements may be repeated in this Division for emphasis or for inclusion of more stringent/additional related requirements. Such repetition shall NOT be construed to reduce the requirements of those Divisions NOR to eliminate other requirements under those Divisions.

B. The requirements of this Section apply to ALL work specified in this Division, unless modified to be of higher quality or more stringent in another Section.

C. THIS PROJECT WILL BE COMMISSIONED. REFER TO COMMISSIONING SPECIFICATION SECTIONS FOR COMMISSIONING INFORMATION AND RESPONSIBILITIES. THE COMMISSIONING PROCESS WILL REQUIRE ADDITIONAL LABOR, MATERIAL AND/OR OTHER COSTS WHICH MUST BE PROVIDED BY THE CONTRACTOR AS PART OF THIS PROJECT.

1.2 INTENT

A. The CONTRACT DOCUMENTS are inclusive of all Drawings and Specifications, both those specifically covering the work of this Division and those covering other subjects of work.

B. It is the intent of the Contract Documents to require finished work, tested and ready for operation.

C. It is not intended that Contract Documents show every pipe, wire, conduit, fitting and appurtenance; however, such parts as may be necessary to complete the systems in accordance with best trade practice and Code requirements and to Architect/Engineer's satisfaction shall be deemed to be included.

D. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. DO NOT SCALE THE DRAWINGS.

1.3 EXAMINATION OF SITE AND CONTRACT DOCUMENTS

A. Before submitting prices or beginning work, thoroughly examine the site and the Contract Documents.

B. No claim for extra compensation will be recognized if difficulties are encountered which would have been revealed by examination of site conditions and Contract Documents prior to executing Contract.

C. Where discrepancies occur within Contract Documents, notify Architect/Engineer, in writing, of discrepancy and request clarification. Until notified of Architect/Engineer's decision, include item or arrangement of better quality, greater quantity or higher cost in Contract price.

D. For material, device and equipment identified on Contract Drawings by manufacturer and/or model: Coordinate with Specification for ancillary requirements and include with furnished item.

E. Notify Architect/Engineer, in writing, of materials and apparatus believed to be omitted, inadequate or unsuitable, or in violation of laws, ordinances, rules or regulations of authorities having jurisdiction. In the absence of such written notice, it is mutually agreed that bid price for work under each Section has included the cost of items required for acceptable satisfactory functioning of entire system.

1.4 DEFINITIONS

A. Where more than one material, item, or grade is listed in same paragraph, first one named is preferred choice.

B. The following terms are used in this Division and are defined as follows:

1. "Indicated", "shown", "noted", "scheduled", "specified": These terms are a cross-reference to graphics, notes or schedules on the Drawings, to other paragraphs or schedules in the Specifications, and to similar means of recording requirements in Contract Documents. NO limitation of location is intended except as specifically noted.
2. "Directed", "requested", "authorized", "selected", "required", "permitted": Where not otherwise explained, these terms mean "directed by the Architect/Engineer", "requested by the Architect/Engineer", etc. However, NO such implied meaning will be interpreted to extend the Architect/Engineer's responsibility into Contractor's area of construction supervision or means and methods.
3. "Provide": To furnish and install, ready for safe and regular operation the item, material or service indicated.
4. "Furnish": To purchase, acquire and deliver to the site, complete with related accessories.
5. "Install": To erect, mount and connect completely, by acceptable methods.
6. "Work": Labor, materials, equipment, apparatus, controls and accessories required for proper and complete installation.
7. “Finished Spaces”: Spaces other than the following:

    a. Mechanical and electrical equipment rooms.
    b. Furred spaces.
    c. Pipe and duct shafts.
    d. Unheated spaces immediately below roof.
    e. Spaces above ceilings.
    f. Unexcavated spaces.
    g. Crawl spaces.
    h. Tunnels.

8. “Exposed”, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical or electrical equipment rooms.
9. “Exposed”, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
10. “Concealed”, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in shafts.
11. “Concealed”, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated structures.
12. "Acceptable equivalent" or "Equal": Of weight, size, design, capacity and efficiency to meet requirements specified and shown, and of acceptable manufacture, as determined in the opinion of the Architect/Engineer.
13. "Acceptable": Acceptable, as determined in the opinion of the Architect/Engineer.
14. "Contractor": General Contractor, Trade Contractor, sub-Contractor, or Construction Manager.
15. "Named" Product: Manufacturer's name for product, as recorded in published documents of latest issue as of date of Contract Documents. Obtain Architect/Engineer's permission before using products of later or earlier model.

1.5 STANDARDS

A. Standards, specifications, and tests of following technical societies, organizations and governmental bodies, as referenced in Contract Documents, are hereby made part of Contract Documents.

1. ANSI: American National Standards Institute
2. ASTM: American Society for Testing and Materials
3. EPA: Environmental Protection Agency
4. FSSC: Federal Specification
5. IRI: Industrial Risk Insurers
6. ISO: Insurance Services Office
7. NBS: National Bureau of Standards
8. NEC: National Electrical Code.
9. NEMA: National Electrical Manufacturers Association
10. NFPA: National Fire Protection Association
11. NSC: National Safety Council
12. OSHA: Occupational Safety and Health Administration
13. UL: Underwriters Laboratories
14. AABC: Associated Air Balance Council
15. ACGIH: American Conference of Governmental Industrial Hygienists
16. ADC: Air Diffusion Council
17. AGA: American Gas Association
18. AMCA: Air Movement and Control Association
19. API: American Petroleum Institute
20. ARI: Air Conditioning and Refrigeration Institute
21. ASCE: American Society of Civil Engineers

22. ASE: Association of Safety Engineers
23. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers
24. ASME: American Society of Mechanical Engineers
25. ASPE: American Society of Plumbing Engineers
26. AWS: American Welding Society
27. AWWA: American Water Works Association
28. CGA: Compressed Gas Association
29. CSA: Canadian Standards Association
30. CISPI: Cast Iron Soil Pipe Institute
31. EJMA: Expansion Joint Manufacturing Association
32. FM: Factory Mutual Engineering Division
33. HIS: Hydraulic Institute Standards
34. IBR: Institute of Boiler and Radiator Manufacturers
35. MCAA: Mechanical Contractors Association of America
36. NEBB: National Environmental Balancing Bureau
37. NOFI: National Oil Fuel Institute
38. SBI: Steel Boiler Industry (Division of Hydronics Institute)
39. SMACNA: Sheet Metal and Air Conditioning Contractors National Association
40. STI: Steel Tank Institute
41. CODE: Codes and regulations of the Federal, State and local governments and of utility companies having jurisdiction, as appropriate.
42. CODE: Codes and regulations of the Federal, State and local governments and of utility companies having jurisdiction, as appropriate.

B. Use of singular or plural reference form in the Contract Documents shall not be construed to limit number of units required. Specifications are intended to define quality and performance characteristics; quantity of units supplied shall be as needed to meet requirements as specified and at a minimum, as shown on Contract Documents.

1.6 PERMITS, LAWS, ORDINANCES AND CODES

A. Contractor shall obtain and pay for permits, inspections, licenses and certificates required for work under this Division.

B. Complete Utility connections as indicated or needed, extension to Project, metering as required, and connection to building systems, including:

1. Apply for all services and pay for all fees, assessments and charges of the Utility for each connection, all in a timely manner and according to the Project Schedule.
2. Provide and install all metering equipment and accessories as required by Utility. Install entire service in accordance with the Utility's requirements or other applicable regulation.
3. Coordinate with Utility to determine scope of work provided by Utility and the part provided by Contractor so that a complete Utility connection is made.
4. Schedule all work required by utility companies in order to maintain project schedule.

C. Contractor shall pay utility company charges associated with work of this Division.

D. Contractor shall comply with laws, ordinances, rules and regulations of Local, State and Federal authorities having jurisdiction; and shall comply with rules and regulations of National Board of Fire Underwriters, National Electrical Code and local utility companies.

E. Contract Documents shall govern whenever they are more stringent than Code requirements.

1.7 COORDINATION DRAWINGS

A. Before materials are purchased or work is begun, prepare coordination drawings showing relationship of work among all trades.

B. Submit completed and signed coordination drawings to the Architect/Engineer for review.

C. Coordination drawings are for use by Contractors and Architect/Engineer during construction and are not replacements for shop, as built, or record drawings required elsewhere in the Contract Documents

1.8 SHOP DRAWING SUBMITTALS

A. General

1. Prior to submission of specific shop drawings, submit for review a preliminary list of intended or proposed manufacturers for all items for which shop drawings are required.
2. Submit through contractual channels for review.
3. Number of copies as directed in DIVISION 1, but not less than 6.
4. Electronic Submittals: Identify and incorporate information in each electronic submittal file.
    a. Electronic Submittals: Submit in accordance with requirements of Project website submittals procedures.
    b. Assemble complete submittal package into a single submittal, incorporating submittal requirements of a single Specification Section.

B. Shop Drawings – Hard Copy: Identify and incorporate information in each submittal as follows:

1. Shop drawings shall include the following information:

    a. Descriptive and product data necessary to verify compliance with Contract Documents.
    b. Manufacturer’s specifications including materials of construction, metal gauge, thickness, and finish.
    c. Certified dimensional drawings including clearances required for maintenance or access.
    d. Performance data, ratings, operating characteristics, and operating limits.
    e. Operating points on curves.

f. Electrical ratings and characteristics.
g. Wiring and control diagrams, where applicable.
h. Certifications requested, including UL label or listing.
i. List of accessories which are required but are NOT being furnished by the product manufacturer or are NOT being provided by this Section. Identify the Section(s) by which the accessories are being furnished or provided.

2. Clearly mark submittals with the following:

a. Where equipment is specified, as follows:

1) Specifications: Section and paragraph.
2) Drawings: Drawing number, schedule, note, and detail, as required.

b. Equipment or fixture identification corresponding to that used in Contract Documents.
c. Accessories and special or non-standard features and materials, which are being provided.

3. The selection and intention to use a product specified by name shall NOT excuse the need for timely submission of shop drawings for that product.
4. For samples submitted in lieu of shop drawings, submit as follows:

a. Submit samples in duplicate.
b. Clearly identify the samples.
c. All samples that are not accepted will be returned.
d. For samples that are approved, one sample will be returned and one sample will be kept by the Architect/Engineer.

5. Upon completion of shop drawing review, shop drawings will be returned, marked with one of the following notations: Furnish as Submitted, Furnish as Corrected, Revise and Resubmit, Rejected, or Submit Specified Item. Use only products whose shop drawings are marked Furnish as Submitted or Furnish as Corrected.

C. Other Submittals

1. Refer to Sections of this Division for additional submittal requirements relating to specific equipment or systems.

D. Submission of shop drawings of an unnamed manufacture or shop drawings at variance with the Contract Documents is NOT a proper request for substitution.

E. Repeat submission of products without addressing all comments from prior review will be returned to the Contractor without review for correction. Note:

1. Contractor may be liable for additional efforts expended by the Architect/Engineer
2. Contractor WILL be liable for impact to project schedule.

F. Test reports are to be submitted to Architect/Engineer for review prior to acceptance of equipment or systems for beneficial use.

G. Shop Drawings - Electronic: Identify and incorporate information in each electronic submittal file as follows:

1. Electronic Submittals: Submit in accordance with requirements of Project website submittals procedures.
2. Assemble complete submittal package into a single submittal, incorporating submittal requirements of a single Specification Section.
3. Metadata: Include the following information as keywords in the electronic submittal metadata:
    a. Project name.
    b. Number and title of appropriate Specification Section.
    c. Manufacturer name.
    d. Product name.

H. Options: Identify options requiring selection by Architect.

I. Deviations and Additional Information: Include relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

J. Resubmittals: Make resubmittals in same manner as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

K. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

L. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

M. Material Safety Data Sheets (MSDS):

1. If required by the Owner, submit MSDSs directly to the Owner; do not submit to Architect.
    a. Architect will not review submittals that include MSDSs and will return without review.
    b. Do not include MSDSs and remove MSDS sheets attached to product data or included with other submittals that require submission to the Architect.

1.9 PRODUCT SELECTION

A. Options for selecting products are limited by Contract Document requirements and governing regulations and are NOT controlled by industry traditions or procedures experienced by Contractor on previous construction projects. Required procedures include, but are NOT necessarily limited to, following specifying methods in Contract Documents:

1. Single Product Manufacturer Named: Provide product indicated.
2. Two or More Manufacturers' Products Named: Provide one of the named products, at Contractor's option, but excluding products which do NOT comply with requirements.
3. "Acceptable equivalent" or "Or Equal": Where named products are accompanied by this term or words of similar effect, provide one of named products or propose substitute product according to paragraph 1.10, SUBSTITUTIONS.
4. Standards, Codes and Regulations: Where specification requires only compliance with a standard, code or regulation, Contractor may select any product which complies with requirements of that standard, code or regulation.
5. Performance Requirements: Provide products which comply with specific performances indicated and which are recommended by manufacturer (in published product literature or by individual certification) for application intended. Overall performance of product is implied where product is specified with only certain specific performance requirements.
6. Prescriptive Requirements: Provide products which have been produced in accordance with prescriptive requirements using specified materials and components, and complying with specified requirements for fabricating, finishing, testing and other manufacturing processes.
7. Visual Matching: Where matching with an established material is required, Architect/Engineer's judgment of whether proposed product matches established material shall be final.
8. "Color as Selected by Architect": Unless otherwise noted, where specified product requirements include "color as selected by Architect" or words of similar effect, the selection of manufacturer and basic product complying with Contract Documents is Contractor's option and subsequent selection of color is Architect's option.

B. Inclusion by name, of more than one manufacturer or fabricator, does NOT necessarily imply acceptability of standard products of those named. All manufacturers, named or proposed, shall conform, with modification by manufacturer as necessary, to criteria established by Contract Documents for performance, efficiency, materials and special accessories.

1.10 SUBSTITUTIONS

A. Contractor's request for substitution may be submitted only after award of Contract. Requests shall be in writing and presented through appropriate contractual channels.

B. Substitution Request to include the following:

1. Detailed comparison of significant differences in quality, construction, performance, features, options, and appearance between specified item and proposed substitution. Citation, where applicable, to where a specified requirement is located in the Contract Documents is to be provided.
2. Statement of effect on construction time, coordination with other affected work, and cost of work.
3. Contractor's statement to the effect that proposed substitution will result in overall work equal to, or better than, work originally intended.

C. Substitution requests will be considered based on all of the following:

1. If extensive revisions to Contract Documents are NOT required.
2. If changes are in keeping with general intent of Contract Documents.
3. If submitted in timely and proper manner, fully documented.
4. If one or more of following conditions is satisfied; all as judged by Architect/Engineer:

    a. Where request is directly related to "acceptable equivalent" clause, "or equal" clause or words of similar effect in Contract Documents.
    b. Where specified product, material or method CANNOT be provided within Contract Time; but NOT as a result of Contractor's failure to pursue the work promptly or properly coordinate Contractor’s efforts.
    c. Where substantial advantage is offered Owner; in terms of cost, time, energy conservation or other valuable considerations; after deducting offsetting responsibilities that Owner may be required to bear, including additional compensation to Architect/Engineer for redesign and evaluation services, increased cost of other work by Owner or separate contractors, and similar considerations.

D. The burden is upon the Contractor, supplier and manufacturer to satisfy Architect/Engineer that:

1. Proposed substitute is equal to, or superior to, the item specified.
2. Intent of the Contract Documents, including required performance, capacity, efficiency, quality, durability, safety, function, appearance, space clearances and delivery date, will be equaled or bettered.

E. Submission of shop drawings of unspecified manufacture or shop drawings at variance with the Contract Documents is NOT a proper request for substitution.

F. Changes in work of other trades, such as structural supports, which are required as a result of substitution and the associated costs for such changes shall be the complete responsibility of Contractor proposing substitution. Except as noted in subparagraph 1.10.C.4 (a) above, there shall be NO additional expense to the Owner.

G. Substitution requests that require the Architect/Engineer to expend additional efforts for review, investigation, verification, or similar activities, will require the Contractor to compensate the Architect/Engineer at the rate of $120/hour if:

1. Architect/Engineer is not familiar with the proposed manufacturer or the proposed product from that manufacturer.
2. Architect/Engineer needs to investigate proposed product, attend presentations, confer with other professionals, contact references, or similar activities that would not otherwise have been required if one of the named products was proposed.
3. Architect/Engineer must travel to the manufacturer's facilities or a representative installation of the proposed product to review, confirm, or assess product characteristics or directly communicate with manufacturer's representatives on technical or product support subjects.

1.11 SAMPLES

A. Submit samples where required or referenced elsewhere in this Division of work.

B. Where in the opinion of the Architect/Engineer, a sample is required to clarify the acceptable characteristics of a material or product, additional samples may be required.

1.12 RECORD DRAWINGS

A. Furnish and keep on the job at all times, a minimum of one complete and separate set of Contract Documents for the purpose of tracking installation of the work.

B. As work progresses, record changes, revisions and additions to the work clearly, neatly, accurately and promptly. Items to be indicated include but are not limited to:

1. Dimensional change of equipment or material
2. Revision to Drawing Detail
3. Location and depth of underground utilities, structures, equipment, tanks, etc - referenced from project benchmarks
4. Location and depth of underslab utilities and distribution
5. Actual routing of distribution systems
6. Revision to power or control wire circuiting/source
7. Actual equipment location
8. Location of concealed distribution work such a pipes, conduits, ducts, etc
9. Location of concealed work and access panels, where access for maintenance or service is required.
10. Changes made by Change Order
11. Details not on original Contract Drawing, but used for installation of the work.
12. Information on concealed elements which would be difficult to identify or measure later.
13. Valve locations and numbers reflecting the final valve tag charts.

C. Indicate daily progress on these prints by coloring in the various lines, fixtures, apparatus and associated appurtenances as they are erected.

D. Approval of requisition for payment for work installed will NOT be given unless supported by record prints as required above.

E. At the conclusion of work, prepare final record drawings reflecting all field recorded data, neatly transferred from documents used in the field to a clean paper set of the Original Contract Documents. Submit record drawings for review by Architect/Engineer. After review and acceptance, the Contractor will be furnished with an electronic set of the original contract documents to be edited to reflect modifications and field data as reported on record drawings. Electronic copy of final "as-built" contract documents to be provided to the Owner in a format agreed upon at the commencement of work.

F. Coordination Drawings are to be updated, reflecting installation of work that differs from that presented on the Coordination Drawings which were signed off at the start of work. All trades will review and sign off on these documents as accurate. Electronic copy of final "as-built" coordination drawings to be provided to the Owner in a format agreed upon at the commencement of work.

G. Refer to DIVISION 1, GENERAL CONDITIONS and SUPPLEMENTARY CONDITIONS for further requirements.

1.13 OPERATING AND MAINTENANCE MANUALS

A. Submit for review, at least two (or greater quantity if otherwise specified in Division 1), operating and maintenance (O&M) manuals for each system or piece of equipment. Applicable content, as generated, is to be collected continuously during the construction process and maintained in a DRAFT manual format for review by the Architect/Engineer at any time.

B. Completed manual will be reviewed by the Architect/Engineer and modifications made as identified, before distribution or use. Acceptance will be required prior to scheduling of Owner Training and Instructions.

C. Required modifications identified during Training and Instruction activities are to be made before final Manual is delivered to the Owner.

D. Refer to DIVISION 1 for additional requirements and procedures relating to O&M manuals.

E. Operating and maintenance manual(s) will be organized with the following fundamental content:

1. Table of Contents and Index

2. Project Information

a. Contractor name, address, contact information, and primary contact individual specific to this project

b. Sub-contractor names, responsibility, address, contact information, and primary contact individual specific to this project.
c. Summary description of project scope and period of time work was executed.

3. Guarantees and Warrantees

a. Documentation describing covered work/materials, effective coverage dates, and terms/conditions
b. Contact information for initiating a claim and responsible party

4. Each Major Building System

a. Supplier information including

1) Technical Support contact
2) Source of parts / replacement units
3) Chain of purchase (Supply house, manufacturer's sales vendor, sub-contractor, etc), including Original order number/identification for tracking purposes

b. Operating Instructions

1) Prepared specific for this project

a) System Description
b) Operating parameters
c) Adjustable settings and purpose
d) Warnings and cautions
e) Sequence of Operations and Control Diagrams

2) Description of training and instruction provided to Owner including:

a) Date(s) of instruction/training
b) Agenda
c) Attendee list

c. Maintenance Instructions

1) Prepared specific for this project

a) Preventative maintenance schedule
b) Summary of consumable materials / regularly replaced elements
c) Recommended stocking materials and specialized tools or equipment necessary to perform regular and preventative maintenance
d) Maintenance contracts secured under this project, or separately contracted for through this provider.

d. Commissioning and Test Reports

1) Documentation of all inspection and testing activities performed with associated reports and corrective measures undertaken (if applicable).
2) Factory test reports
3) Certification letters for equipment manufacturers attesting to the complete and satisfactory installation and operation of systems/products.
4) Seismic inspection and certification
5) Special inspections
6) Sign off by Authorities Having Jurisdiction
7) Air and water balance report.

e. Parts / Material List

1) Bill of materials for each system or piece of equipment

f. Product Literature

1) Copy of shop drawings reflecting final acceptance by Architect/Engineer, with modifications made reflecting changes to the installed work which is not represented accurately.

g. Manufacturer's Operation & Maintenance Literature

1) Materials provided with equipment/products shipped for use on project
2) Supplementary materials which are required to provide the Owner with a complete representation of manufacturer's instructions and recommendations.

F. In addition to the above, the following Content is to be included in the Operation & Maintenance Manual(s):

1. BMS and temperature control shop drawings.
2. HVAC testing and balancing reports.
3. Commissioning and testing reports.
4. Other data, as required under pertinent Sections of these Specifications.

1.14 GUARANTEE

A. Furnish standard manufacturers' guarantees for work under this Division. Such guarantees shall be in addition to, and NOT in lieu of, other liabilities under the law or by other provisions of the Contract Documents.

B. Materials, equipment and workmanship shall carry the standard warranty against defects in material and workmanship. Failure which may develop due to defective or improper material, equipment, workmanship or design shall be made good, forthwith, by and at the expense of

the Contractor, including damage done to areas, materials and other systems resulting from this failure.

C. Guarantee that all elements of the systems are of sufficient capacity to meet the specified performance requirements as set forth in Contract Documents.

D. Upon receipt of notice from Owner of a failure of system(s) or component(s) during the guarantee period, replace affected components within reasonable time period at no additional cost.

E. Guarantee period shall extend for one year from Date of Substantial Completion.

F. Before final request for payment, furnish written guarantee covering above requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Products shall be undamaged and unused at time of installation and shall be complete with accessories, trim, finish, safety guards and other devices and details needed for complete installation and for intended use.

B. Where available, products shall be standard products of types which have been produced and used previously and successfully on other projects and in similar applications.

C. Labels and Stamps

1. Locate labels and stamps required to be observed after installation on accessible surfaces. In occupied spaces, select locations that are not conspicuous.
2. Locate labels and stamps not required to be observed after installation on concealed surfaces.

D. Provide corrosion resistant fasteners of galvanized or stainless construction where exposed to moist corrosive conditions. Including but not limited to tunnels, manholes, greenhouses and exterior to the building.

PART 3 - EXECUTION

3.1 ARRANGEMENT OF WORK

A. Consult Architectural Contract Drawings and Details for exact locations of fixtures and equipment. If exact location is not given, obtain information from Architect/Engineer. Verify measurements in field. Base measurements on Architect/Engineer's established benchmarks.

B. Install work as closely as possible to layouts shown on Contract Drawings. Modify work as necessary to:

1. Provide maximum possible headroom and space clearance on each side.
2. Provide adequate clearance and ready access to all parts of the work, for inspection, operation, safe maintenance and repair, and code conformance.
3. Coordinate and arrange work to avoid conflicts with work of other trades, to avoid unnecessary cutting and patching, and as needed for satisfactory space conditions shown on coordination drawing submittals.
4. Where space appears inadequate, consult Architect/Engineer before proceeding with installation.

C. Coordinate installation of required supporting devices.

D. Set sleeves in cast-in-place concrete for services that will need to pass through concrete. Coring of installed concrete is not intended and the Contractor will be responsible for determining the impact on structural integrity, certifying that there will be no impact, and any remedial work required to accommodate impact from coring.

E. Work shall present a neat coordinated appearance.

3.2 COORDINATION

A. Examine Contract Documents and coordinate with Contractor and other trades as necessary to facilitate the progress of the work.

B. Each trade shall keep Contractor and other trades fully informed as to shape, size, and locations of openings, chases, equipment, panels, access doors, sleeves, inserts and anchor bolts required; whether temporary or permanent. Coordinate sizes, depths, fill and bedding requirements with excavation trades. Give sufficient advance notice so that coordination may be completed in advance. If information is not furnished in proper and timely fashion, the trade involved shall do own cutting and patching or have same done by Contractor, without additional cost to Owner.

C. Coordinate size and location of concrete bases with DIVISION 3 and the following:

1. Floor Drains and underslab utilities
2. Dimensional requirements for embedded anchors as necessary for support, vibration isolation, and seismic restraint.
3. Access and walkway requirements
4. Work of other trades

D. Particular emphasis is placed on timely installation of major apparatus and furnishing of other trades and Contractor with relevant information.

E. Do NOT install a system until critical components of system and related systems have been coordinated and applicable shop drawings have been accepted.

3.3 WORKMANSHIP

A. Work covered under this Division shall be constructed and finished in every respect in a workmanlike and substantial manner.

B. Equipment and materials shall be new, of first quality, selected and arranged to fit properly into spaces indicated.

C. Obtain detailed information from manufacturer as to proper methods for installation and connections. This includes such tests as equipment manufacturer recommends. Where documentation regarding installation is NOT obtainable, work shall be installed in accordance with best trade practice.

1. Unless specifically indicated otherwise on Contract Documents, equipment and materials shall be installed in accordance with manufacturer's recommendations.
2. Notify Architect/Engineer of conflicts between manufacturer's recommendations and Contract Documents requirements, and request clarification before proceeding with installation.

D. Where equipment, piping, ductwork, conduit, etc. is exposed, color of finish or paint shall be as selected by Architect/Engineer.

3.4 OPERATION OF SERVICES AND UTILITIES

A. During the construction period and until finally inspected, tested and accepted, maintain new services and utilities.

B. Shutdown of existing services and utilities shall, without exception, be coordinated with the proper utility and with the Owner as to date, time of day, and duration.

1. Notify Architect/Engineer and Owner of estimated duration of shutdown period at least ten days in advance of date when shutdown is proposed. Approval of shutdown shall be obtained from proper utility and Owner, before any service is interrupted.
2. Work during shutdown period shall be arranged for continuous performance, including overtime if required, to ensure that existing operating services will be shut down only for time actually necessary to complete connections.

3.5 PROTECTION

A. Contractor shall be responsible for work and equipment until fully inspected, tested and accepted. Carefully store materials and equipment which are not immediately installed after delivery to site. Close open ends of work with temporary covers or plug during construction to prevent entry of obstructing material or damaging water.

B. Equipment shall be protected against damage while in storage either on or off the construction site. The equipment shall be stored in a dry environment with temperature and controlled to within ranges specified by the manufacturer. Space heaters shall be installed and energized when required to control humidity. Store light sensitive materials where not subjected to direct sunlight.

C. Protect work and material of other trades from damage that might be caused by work of this and other Divisions and correct damage thus caused.

D. Maintain protective measures used for transport of equipment or materials to project site until ready to set and connect utilities and related work. If protective covers need to be removed for inspection or coordination of work, repair or replace to equivalent.

3.6 IDENTIFICATION

A. Distribution systems such as pipes, tubing, conduits, sheetmetal, insulation, etc shall have following information clearly printed on the material: manufacturer's name, material grade, gauge, thickness, type, and data to identify required methods of attachment; as applicable. Unmarked material shall NOT be used.

B. Permanent nameplates shall be provided on each piece of service-connected, power-operated, or distribution equipment, on easily accessible surface. Nameplate shall include product name, model number, serial number, capacity, speed, ratings, and similar essential operating data.

1. Manufacturer's nameplate, name, trademark and address shall be attached permanently to equipment and material furnished. Nameplate showing distributor or Contractor will NOT be permitted.
2. Unless otherwise specified or requested, letters and numbers shall be 1/2” high.
3. Attach nameplates with screws or rivets. Wherever covers of adjacent units are interchangeable, attach nameplates to wall or backboard rather than covers.

C. Unless specified elsewhere in this Section, labels shall be provided to indicate equipment according to designations used in Contract Documents. Label shall be plastic nameplate with letters and numbers 1-1/2” high. Furnish directory indicating number, location and use of each item. After finish painting is completed, apply identification label where it will be readily visible from normal operating position on floor.

3.7 LUBRICATION

A. Equipment shall be furnished and installed so that lubrication points are conveniently and readily accessible for maintenance. Make these provisions by whatever means is appropriate: extended fittings, access doors, equipment location, etc.

B. No equipment shall be operated for temporary service or for testing purposes without proper lubrication. Items requiring lubrication shall be left freshly and fully lubricated at time of substantial completion.

C. Prior to substantial completion, deliver to Owner, along with itemized list: one complete new set of special lubrication devices required for servicing, such as grease guns, fittings and adapters.

3.8 ATTACHMENT OF SUPPORTS TO BUILDING STRUCTURE

A. Equipment shall be securely attached to building structure in acceptable manner. Attachments shall be of strong and durable nature as determined by Architect/Engineer.

B. Attachment of supports to roof decking is NOT permitted. Pipes, ducts, conduits, boxes, etc. must be supported from building structural framing (bar joist, beams, columns) or by supplementary members installed by the Contractor, spanning structural framing in a method acceptable to the structural engineer.

C. Cut, Fit and place miscellaneous metal supports for installation of work.

D. Field Welding: Comply with AWS D1.1 or other applicable standards

E. Refer to DIVISION 5 for material specification of supplemental members to be installed.

3.9 ACCESSIBILITY, ACCESS PANELS AND ACCESS DOORS

A. Locate equipment which must be serviced, including motor starters, switches, panels and junction boxes, in accessible locations if at all possible. For other locations, furnish access panels as described under DIVISION 1.

B. Access doors shall be located to conveniently serve intended purpose and shall be installed so that adjacent piping, equipment and structures do NOT render doors unusable.

C. Access doors are not required in removable panel ceilings if suitable identifying markers are provided to indicate access locations.

D. During project closeout, Contractor shall perform walk-through identifying and demonstrating access to equipment for service and/or replacement. Walk-through shall be arranged at times convenient for Engineer and Owner to attend.

1. Equipment with insufficient access shall be relocated or provided with additional access panels at no additional cost to Owner.
2. Trade responsible for access problem shall be responsible for costs of access modifications. In general, this shall be understood to be the trade installing the equipment. If access problem was caused by architectural layout changes which occurred subsequent to equipment installation, cost of access modifications shall be borne by trade responsible for architectural changes.

3.10 WATERPROOFING

A. Where work pierces waterproofing, including waterproof concrete and floor of a wet area, submit method of installation for review by the Architect/Engineer before work is done.

B. Provide necessary sleeves, caulking and flashing required to make openings waterproof. See DIVISION 7 on WATERPROOFING.

3.11 GROUTING

A. Mix and install grout for equipment base bearing surfaces, base plates, and anchors

3.12 BASES AND SUPPORTS

A. Unless noted otherwise, provide necessary supports, rails, framing, bases and piers required for equipment furnished or installed under this Division.

B. Unless otherwise indicated: floor-mounted equipment shall be mounted on concrete pads. Concrete and associated reinforcing materials shall be as specified in DIVISION 3, CONCRETE.

1. Pads shall be three-inch thick minimum. Pads for seismically supported equipment shall extend at least 6 inches beyond equipment footprint. Coordinate final extension requirements with approved seismic shop drawing calculations and details. All other pads shall NOT extend more than one inch beyond equipment footprint. Top edge of pads shall be chamfered.
2. Furnish dimensional and load information so that shop drawings for pads may be submitted and reviewed prior to pad installation.
3. Equipment shall be firmly grouted into concrete pads and anchor bolted.

C. Where mounted on the floor: Foundations, supports, pads, bases and piers shall be of the same finish quality as the adjacent flooring material.

D. Equipment supports shall be designed and constructed so that equipment will be capable of resisting both vertical and horizontal movement. Refer to Section “VIBRATION AND SEISMIC CONTROLS” in this Division.

3.13 PAINTING

A. Unless otherwise specified, materials furnished under this Division shall have prime coat and standard manufacturer's finish.

B. Finish painting of exposed work and equipment is covered under DIVISION 9.

C. Paint equipment and appurtenances in concealed and unfinished areas with one coat of rust-inhibiting paint or with an appropriate bitumastic protective product designed for the intended application. Asphalt paint is NOT acceptable. Items to be painted shall include, but not be limited to: non-insulated hangers, supports, piping, conduit, tanks and other ferrous metal work, which are concealed or inaccessible but not galvanized.

D. Special care shall be taken to avoid painting or spattering equipment nameplates.

E. Cooperate in identifying systems for painters. Refer to paragraph, IDENTIFICATION.

3.14 TESTS - GENERAL

A. Make final adjustments to equipment before testing. Manufacturer's authorized representative shall verify proper installation and adjustment prior to startup of major equipment; refer to paragraph, OPERATING AND MAINTENANCE MANUALS.

B. Furnish labor, materials, instruments, supplies and services necessary for testing required under this Division. Correct defects appearing during tests, and repeat tests until no defects are disclosed. Final tests shall be made in Architect/Engineer's presence.

C. Use true RMS ammeter to measure current, for equipment which may have harmonic (non-linear) load component.

D. Notify Owner, Architect and Engineer of testing schedule at least 48 hours in advance of tests.

E. Perform specified tests and tests required by legal authorities and by agencies having jurisdiction over this Work. Tests shall be performed to the satisfaction of legal authorities, agencies having jurisdiction, and Owner.

F. Each piece of equipment, including motors and controls, shall be operated continuously for minimum test period of one hour.

G. If manufacturer's startup services are specified under other Sections in this Division, furnish services of factory-trained service engineering representative to provide following. If manufacturer's startup services are not required, Contractor shall furnish following services.

1. Inspection of equipment/system installation.
2. Assistance in initial startup and adjustment of equipment; including necessary time to achieve proper installation and adjustments.
3. Instruction of Owner's staff; see paragraph, INSTRUCTIONS.

H. Upon completion of tests, demonstrate the following:

1. Equipment and systems are installed and operating in accordance with manufacturer's specifications and instructions and with Contract Documents.
2. Proper adjustment of equipment and systems.
3. Systems are properly cleaned and free of contaminants.
4. Systems are properly phase balanced.
5. Circuits and motorized equipment are equipped with proper overload protection and are not operating under overload.
6. Instruments are recording properly.

I. Refer to testing requirements in other Sections of this Division for addition work.

3.15 INSTRUCTIONS

A. Arrange for each installer of work requiring continuing maintenance or operation, to meet with Owner's personnel at project site and instruct them in the operation and maintenance. Include instruction by manufacturer's representatives where installers are not expert in the required procedures. Instruction periods for all trades shall be minimum of 8 hours total; refer to individual SECTIONS for further requirements.

B. Instructions include, but are not limited to, the following:

1. Review of Operation and Maintenance manuals, record documentation, tools, spare parts and materials, lubricants, fuels, identification system, control sequences, hazards, cleaning, and similar procedures and facilities.
2. Demonstration of the following:

    a. Start up procedures
    b. Shutdown procedures
    c. Emergency operations
    d. Noise/vibration control adjustments
    e. Safety concerns and protective equipment
    f. Economy/efficiency adjustments
    g. Cleaning
    h. Similar operations

3. Review of applicable guarantees and warranties.
4. Demonstration of procedures for routine maintenance, at the equipment involved, to ensure proper accessibility to components involved.

3.16 QUIET OPERATION

A. Equipment and material provided as part of the Work shall NOT produce sound level greater than 55 decibels (or level required by Code, if more stringent) in adjacent occupied areas. Sound level shall be as measured on A-weighting scale of sound level meter or sound survey meter.

B. Methods described in ASHRAE guide and data books may be used to determine sound level of equipment when total of background sound and equipment sound exceeds the required minimum.

C. Contractor shall ensure that equipment and materials provided as part of the Work do NOT produce excessive noise/vibration and do NOT transmit excessive noise/vibration to occupied spaces. If objectionable noise/vibration occurs, Contractor shall provide systems, devices, and equipment necessary to eliminate objectionable noise/vibration at no additional cost to Owner.

D. Refer to VIBRATION AND SEISMIC CONTROLS FOR MECHANICAL SYSTEMS for further requirements.

3.17 FINAL CLEANING

A. Clean each surface of each unit of work, to normal "clean" condition expected for a first-class building cleaning and maintenance program. Comply with manufacturer's instructions for cleaning operations. The following are examples, but not limitations, of cleaning required:

1. Remove labels which are not required as permanent labels.
2. Clean transparent materials, removing substances which are noticeable as vision-obscuring.
3. Clean exposed hard-surfaced finishes, until free of dust, stains, films and similar noticeable substances.
4. Wipe surfaces of mechanical and electrical equipment clean, remove excess lubrication and other substances.
5. Remove debris and surface dust from limited-access spaces such as plenums, shafts, and ceiling spaces.
6. Clean lighting fixtures and lamps; removing dust, smudge marks and protective wraps; so as to function with full efficiency.

3.18 DEMOLITION, RENOVATION, IMPACT TO EXISTING

A. Demolition:

1. In areas where demolition of systems of this Division are indicated, the following requirements apply:

    a. Disconnect and remove from the project site, and dispose of in a legal manner, all materials not otherwise identified to be handled otherwise.
    b. Investigate impact to areas outside the designated area for demolition and identify any impact that demolition may have on those areas.
    c. Building structure, partitions, floors, and walls to remain shall not be impacted by demolition work.

B. Selective Demolition

1. Major changes to existing building spaces and systems have been shown on Contract Drawings; minor changes have NOT been shown. Contractor shall anticipate that there will be numerous minor changes including:

    a. Removal and/or relocation of pipes, conduits, wiring, etc
    b. Removal and/or relocation of wall and ceiling mounted devices due to architectural revisions or phasing
    c. Temporary relocation of existing devices or distribution equipment to permit installation of new work.

d. Temporary work and modifications to existing systems to maintain Owner’s use and operations in areas outside the boundaries of the work.
e. Work related to phased demolition of existing systems
f. Work related to phased installation of new work

2. Remove, store, clean and relocate equipment designated to be relocated and reused.
3. Material which is removed and is not designated for reuse shall, at the Owner's option, either:

a. Be delivered to Owner's storage location
OR
b. Become Contractor's property and be removed from the site and disposed of properly

END OF SECTION 230500

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SECTION 230510 – PROJECT COORDINATION AND COORDINATION DRAWINGS

SECTION 230510 - PROJECT COORDINATION AND COORDINATION DRAWINGS

PART 1 - GENERAL

1.1 REFERENCES

A. Refer to the GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS and applicable parts of DIVISION 1 for other general requirements.

B. GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS and DIVISION 1 paragraphs may be repeated in this Division for emphasis or for inclusion of more stringent/additional related requirements. Such repetition shall NOT be construed to reduce the requirements of those Divisions NOR to eliminate other requirements under those Divisions.

C. Refer to other Sections of this Division for detailed specifications on the work of this Division.

D. THIS PROJECT WILL BE COMMISSIONED. REFER TO COMMISSIONING SPECIFICATION SECTIONS FOR COMMISSIONING INFORMATION AND RESPONSIBILITIES. THE COMMISSIONING PROCESS WILL REQUIRE ADDITIONAL LABOR, MATERIAL AND/OR OTHER COSTS WHICH MUST BE PROVIDED BY THE INDIVIDUAL TRADE CONTRACTORS AS PART OF THIS PROJECT.

1.2 INTENT

A. The Contract Documents define a complete installation, comprised of many individual components, assemblies and systems. It is the intent of these documents that the work of all trade contractors, sub-contractors, and all sub-contracted entities performing the work be coordinated to result in finished project, meeting the performance requirements of these documents.

B. The use of the terms “contractor”, “trade contractor”, or “sub-contractor” in this Section is to be interpreted as referring to all trades, singularly and collectively.

C. Definition of roles and responsibilities as pertains to the scope of this section:

1. Contractor:

a. Management, Schedule, and Execution of project coordination and coordination drawing process.
b. Translation of Design Intent and Project requirements, presented within the Contract Documents, into coordinated layout and fabrication drawings.
c. All reasonable efforts to resolve apparent conflicts in the work, identified in the coordination process, without impact to Design Intent and Project Requirements.

2. Architect/Engineer:

    a. Interpretation of Contract Documents
    b. Prioritization of Project Requirements where necessary to resolve multiple requirements determined as in conflict after Contractor's coordination activities are exhausted.
    c. Review and assistance with resolution of apparent conflicts identified by Contractor, provided that reasonable efforts by Contractor have been undertaken to first resolve apparent conflict.
    d. Accept or Reject Contractor's proposed adjustments to the work.

1.3 RELATED SECTIONS

A. Refer to the following related sections:

1. DIVISION 1 – Section(s) related to Phasing, Construction Schedule, Procedures, and Coordination of the work.
2. DIVISION 21 – Section related to "Project Coordination and Coordination Drawings"
3. DIVISION 22 – Section related to "Project Coordination and Coordination Drawings"
4. DIVISION 23 – Section related to "Project Coordination and Coordination Drawings"
5. DIVISION 26 - Section related to "Project Coordination and Coordination Drawings"
6. DIVISION 27 – Section related to "Project Coordination and Coordination Drawings"
7. DIVISION 28 – Section related to "Project Coordination and Coordination Drawings"

1.4 SEQUENCE OF WORK

A. Before commencement of project coordination and before procurement of materials, Contractor and all sub-Contractors, shall familiarize themselves with the work and requirements of all trades.

B. Phased Sequence of Work:

1. If provided, review phasing plans and requirements set forth in the Contract Documents and any Supplementary information provided.
2. Contractor is responsible for generating a complete phasing plan for the project.
3. Identify work that requires careful scheduling in coordination with proposed phasing in order to meet project requirements for completion dates, and operation of systems.
4. Obtain clarifications from Owner and Architect/Engineer on requirements or conditions that directly affect scope work within specific phases of work.
5. Make adjustments to phasing plan and scope or work per phase after review and acceptance by Owner and Architect/Engineer.

C. Project Schedule(s):

1. Review schedules published in the Contract Documents and any supplementary information provided.

2. Coordinate sufficient time allocations in the Contractor's schedule for Shop Drawing submission and review, Procurement of materials, and the coordination process.
3. Identify elements that will establish the critical path to project completion at the designed date. Adjust schedule of work to accommodate the proper sequence of work as outlined herein.
4. Coordinate equipment arrival and rigging access to interface with overall project sequence. Coordinate and plan with manufacturer for any equipment "splits" required to set equipment in final location. If field breakdown is required, directions shall be provided in writing from the manufacturer for procedures to be followed. Any field breakdown and reassembly is to be inspected by equipment manufacturer before final connections are made. Ensure an adequate pathway is available, such as corridors and openings, to transport equipment.

D. Investigation and Collection of Relevant Information:

1. Review all Contract Documents and referenced standards.
2. Review all Owner requirements.
3. Investigate field conditions as it relates to installation and coordination of work.
4. Identify areas where investigation requiring partial deconstruction of existing or newly constructed work is required to fully inform the Contractor on conditions that are critical to coordination of the work.
5. Perform investigations in coordination with the work of other trades and/or owner's use of existing areas.

E. Equipment Shop Drawings:

1. Shop drawings for major equipment and equipment with service connections, should be submitted and accepted prior to coordination drawing efforts in areas adjacent to equipment placement. Information on utility connections, weight and dimensions, access, working clearances, rigging methods, etc are to be represented on the Coordination Drawings for the specific equipment being installed.

F. Preparation of Coordination Drawings:

1. Coordination Drawings are to be prepared as a collaborative effort between all trade Contractors working on the project.
2. The following information, as a minimum, is to be represented on the Coordination Drawing – Floor Plans:

    a. Accurately scaled to no smaller than 1/4" = 1'-0". Where areas are congested and smaller scale is insufficient to clearly detail aspects of the work, Contractor to provide documents at larger scale.
    b. Floor plan layout of walls, doors, windows, equipment pads, etc.
    c. Building structure, dimensionally accurate with depth and elevation.
    d. Ceiling systems, including reference to height and type of ceiling. Locate coordinated position of access doors where required to gain access to work. Soffits and other ceiling contours represented.

e. Indicate by shadow or similar means, required access points for service to above ceiling components such as valves, clean-outs, strainers, fire dampers, VAV boxes, FCU's, pull boxes, control panels, etc.

f. HVAC trade work:

1) Ductwork
2) Piping, including expansion loops
3) Elevation of ductwork and piping including allowances for insulation thickness indicated
4) Equipment – base/floor mounted
5) Equipment – suspended
6) Valves on distribution systems
7) Control Panels
8) Working clearances

g. Electrical Trade Work:

1) Electrical distribution equipment
2) Conduit runs for major feeders (panels and major equipment)
3) Branch circuit wiring collection boxes
4) Main telecommunications conduits, racks, and/or open cabling space allowance
5) Pull boxes for major feeders and telecom conduits
6) Cable tray
7) Lighting
8) Ceiling mounted devices such as speakers, detectors, sensors, etc
9) Control panels
10) Working clearances both at floor level access and overhead access
11) Duct smoke detectors, indicated on duct layouts

3. All trades contributing to the development of the Coordination Drawings are to sign off on the final completed documents, including the General Contractor (if applicable) and/or Construction Manager (if applicable).

G. Equipment Placement:

1. No equipment is to be placed before all connections and provisions have been verified and coordinated.
2. Working space and clearances for service are to be maintained and verified prior to placement of equipment support provisions such as pads, frames, supports, dunnage, curbs, or anchors.

H. Installation of Work:

1. Work is to be installed in conformance with coordination drawings that have been signed off and accepted.
2. Work installed prior to completion of the Coordination Process will be subject to removal at the Contractor's expense.

I. Changes made in the field:

1. The Coordination Drawings are to be periodically updated during the project to reflect changes to the work which are made by Change Order or adjustments for other cause.
2. Changes that result in coordination conflicts are to be resolved immediately before related work continues.

1.5 RENOVATIONS & EXISTING CONDITIONS (Where Applicable)

A. The Contract Documents do not necessarily show all existing conditions, all new work to existing work interfaces, nor the complete extent of patching, repair, and renovation.

B. Unless otherwise noted, work shall be planned and executed assuming that areas not scheduled at that time to be renovated are intended to be in use and occupied. Existing services must be maintained that serve occupied areas of the building(s) or site.

C. Thoroughly study, examine, and investigate existing field conditions including, but not limited to, conditions in areas of limited accessibility such as crawl spaces, plenums, attics, chases, and above ceilings.

D. Plan and execute investigative work, including selective demolition, of concealed spaces where new work is scheduled to be installed.

E. Coordinate investigative efforts so that the disruption of Owner's operations is not affected. Work after Owner's normal hours of operation may be required and is to be provided.

F. Interruption of building services to be scheduled to minimize impact to the Owner's operations. Interruptions may only be made after timely notification to Owner and any involved utilities. Advance notification requirements are to be investigated and incorporated into project schedule(s) to avoid impact to the orderly installation of the work. Overtime or after hours work may be required and is part of Contractor's responsibility.

1.6 AVAILABILITY OF ELECTRONIC FILES

A. Electronic files (CAD) of the project floor or site plans may be available from the project Architect (or Engineer). Refer to other Sections and Instructions of the Contract Documents to confirm if these will be made available. Unless otherwise stated, assume that electronic files will not be made available.

B. Electronic files (CAD) of the project's Mechanical and Electrical Contract Documents will not be made available unless otherwise stated.

C. Electronic Files for BIM Projects (where applicable). BIM Model content related to the Mechanical and Electrical systems will not be released for the purposes of coordination by the contractor.

1.7 SUBMITTALS

A. Submittal of Coordination Drawings to be made with sufficient time planned for review and revision. The potential for additional steps of coordination prior to the scheduled commencement of work should be anticipated.

B. Separately developed Coordination Drawings may be required for elements of the work. Refer to requirements outlined later in this Section.

C. Refer to other Sections and Divisions of these Specifications for other related Submittal requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. No specific materials are specified in this section. Refer to other sections of this Division and other Divisions of the Specifications for material specifications.

PART 3 - EXECUTION

3.1 TRADE SPECIFIC LAYOUT AND FABRICATION DRAWINGS

A. Trade or system specific layout drawings may be required in other Section of this and other Divisions. Content that is common between these layout drawings and requirements for the Coordination Drawings shall be coordinated and developed in parallel where practical.

3.2 SITE WORK AND UTILITIES

A. Coordination Drawing prepared reflecting:

1. Underground site utilities, size and invert
2. Site Structures for Utility Distribution, size, placement, invert
3. Include concrete encasement dimensions where applicable

3.3 COORDINATION DRAWINGS – DEMOLITION

A. For renovation projects that require selective demolition, prepare a separate coordination drawing based on existing conditions, indicating:

1. Points of cut/cap for existing systems to remain
2. Major equipment removals and associated services

3.4 COORDINATION DRAWINGS – NEW WORK

A. Coordination Drawings prepared as indicated in this Section.

3.5 RISERS, SHAFTS, AND CHASES

A. Provide sections of all risers that extend beyond two floor levels of the building.

3.6 SECTIONS AND ELEVATIONS

A. Minimum of 1 longitudinal and 1 cross section through every Mechanical Room and Major Electric Service and Distribution Room

B. Cross sections to be provided in areas on congestion where services are stacked in elevation.

END OF SECTION 230510

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SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation; and general requirements for direct-drive equipment mounted on an EC external rotor motor with integrated control electronics and installed at equipment manufacturer’s factory or shipped separately by equipment manufacturer for field installation

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

C. Approvals of UL1004-7 (Standard for Electronically Protected Motors) and CSA C22.2 No. 77 (Motors with Inherent Overheating Protection) for EC motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T .

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable-Frequency Controllers: [Ratings, characteristics, and features coordinated with and approved by controller manufacturer.]

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Motors shall have a shaft grounding brush to prevent bearing failure from presence of voltage on the shaft.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.6 EC MOTORS

A. Description: Direct-drive equipment mounted on an EC external rotor motor with integrated control electronics.

B. Efficiency: EC motors to meet or exceed Super Premium Efficiency Class (IE4).

C. Service Factor: 1.10.

D. Bearings: Maintenance free ball bearings with long term lubrication and nominal service life of at least 40,000 operational hours.

E. Temperature Rise: Match insulation rating.

F. Insulation Rating:

1. For motors greater than 7HP – Class F or better
2. For motors 2.5-7HP – Class B or better
3. For motors 1-2.5HP – Class A or better

G. Electrical Requirements:

1. Motor to be suitable for use with all standard AC power supply systems.
2. Motor to include integrated electronics, low-noise commutation logic, and 100% speed control.
3. Motor electronics to take control input of 0-10 VDC/PWM for open loop speed control.
4. Each EC motor assembly shall have integrated harmonic reduction/power factor correction. Manufacturer to provide harmonic data.
5. Motor to have over temperature protection.
6. Electronics to have line under-voltage and phase failure detection capabilities.
7. Electronics to impose motor current limit.
8. Motor capable of soft starting.
9. Motor/electronics to have EMC interference immunity in accordance with EN 61000-6-2 (Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments).

H. Mechanical Requirements:

1. Complete motorized impeller assembly shall have been statically and dynamically balanced by the manufacturer per ISO 21940-11 or equivalent.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

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SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING AND DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to Section, “COMMON WORK RESULTS FOR MECHANICAL”.

C. Refer to Division 07 Specification – “PENETRATION FIRE STOPPING”.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Sleeves: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :

1. Advance Products & Systems, Inc.
2. Metraflex Company (The).
3. Pipeline Seal and Insulator, Inc.
4. Proco Products, Inc.
5. Thunderline Link Seal.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: Interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

a. EPDM-Standard and Chemical Service -40°F to 250°F
b. Nitrile-Oil Resistant Service -40°F to 210°F
c. Silicone – High/Low Temperature Service -67° to 400°F

2. Pressure Plates: Carbon steel Plastic Stainless steel.

a. Plastic – Standard Service
b. Plastic –Oil Resistant Service
c. Steel – High/Low Temperature Service

3. Connecting Bolts and Nuts: Length required to secure pressure plates to sealing elements.

a. Stainless Steel – Standard Service
b. Stainless Steel – Oil Resistant Service
c. Steel With Corrosive Resistant Coating – High/Low Temperature Service

2.3 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Presealed Systems.

B. Description: Manufactured, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 FIRE STOPPING SYSTEMS

A. Fire and or smoke stopping shall be provided where mechanical systems penetrate rated assemblies. It is intended that ratings and sealing requirements will be specified under architectural separate divisions of work. In the event that sealing methods or products are not specified elsewhere, the following shall be used as the basis for executing this work.

B. Use only firestop products that have been UL 1479 or ASTM E 814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

C. Subject to compliance with through penetration firestop systems listed in the UL Fire Resistance Directory, provide products of the following manufacturers as identified below:

1. Hilti, Inc., Tulsa, Oklahoma
   800-879-8000
   www.us.hilti.com
2. Provide products from the above or other acceptable and equivalent manufacturer.

D. Foams, intumescent, sealants, or caulking materials for use with non-combustible items, and/or flexible cable or cable bundles, the following products are acceptable:

1. Hilti Intumescent Firestop Sealant
2. Hilti Fire Foam
3. Hilti Flexible Firestop Sealant
4. Hilti Elastomeric Firestop Sealant

E. Intumescent sealants, caulking materials for use with combustible items (penetrants consumed by high heat and flame) including PVC jacketed, flexible cable or cable bundles, and plastic pipe, the following products are acceptable:

1. Hilti Intumescent Firestop Sealant

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (2-inch when seismic) annular clear space between piping and concrete slabs and walls.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants." Where no barrier is specifically defined by the Architect, the contractor shall install loose fill of therma-fiber and caulk sealant for acoustic and pest/rodent mitigation.

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

F. Provide curbed or sleeved water-stop at all floor duct penetrations including intermediate floors. Penetrations shall be sealed and caulked as required to prevent the vertical passage of water.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in all exterior walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

C. Exterior below-grade installations shall utilize stainless steel bolts and plates.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Coordinate OD of sleeve with wall placement, and width dimensions, to ensure the sleeve does not impact wall finishes. This may require dimensional coordination drawings collaboratively developed by all trades.

C. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

D. Secure nailing flanges to concrete forms.

E. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

    a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with link seals.
    b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with link seals.

2. Exterior Concrete Walls below Grade:

    a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.

        1) Select sleeve size to allow for 2-inch annular clear space between piping and sleeve for installing sleeve-seal system.

    b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.

        1) Select sleeve size to allow for 2-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.

b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

5. Interior Partitions:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 230517

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SECTION 230529 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. The Professional Engineer shall be legally qualified to practice in jurisdiction where project is located, and shall be experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for design and installation of hangers and supplies.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

C. Refer to Section 230548 “Vibration and Seismic Controls for HVAC Piping and Equipment” for additional requirements.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Signed and sealed by a qualified Professional Engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.
5. Seismic restraints.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

D. Welding certificates.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Cooper B-Line, Inc.
    b. Flex-Strut Inc.
    c. Thomas & Betts Corporation.
    d. Unistrut Corporation; Tyco International, Ltd.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Hot-dipped galvanized.
8. Paint Coating: Epoxy.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International; a subsidiary of Mueller Water Products Inc.
b. Empire Industries, Inc.
c. ERICO International Corporation.
d. Haydon Corporation; H-Strut Division.
e. NIBCO INC.
f. PHD Manufacturing, Inc.
g. PHS Industries, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Coating: [**Zinc**] [**Paint**].

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
2. Piping Technology & Products, Inc.
3. Rilco Manufacturing Co., Inc.
4. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

1. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40 galvanized, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with hot dipped galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
5. C-Clamps (MSS Type 23) with retaining clips: For structural shapes.
6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
11. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.

c. Heavy (MSS Type 33): 3000 lb.

12. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
14. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39) for insulated piping without vapor barrier: To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction..

END OF SECTION 230529

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SECTION 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Valve tags.
6. Warning tags.
7. Access identification.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: [Aluminum, 0.032-inch] [or] [anodized aluminum], [0.032-inch)] minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches , 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, [1/16 inch)] thick, and having predrilled holes for attachment hardware.
2. Letter Color: White Background Color: Black.
3. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless-steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Design, and colors should comply with OSHA regulations and ANSI/ASME A13.1 (2007)

C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch

E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

F. Fasteners: Stainless-steel [rivets or self-tapping screws].

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size and label length to be in accordance with ASME/ANSI A13.1 (2007) requirements which are in the table below.

Outside Pipe Diameter Including Covering, inch	Minimum Length of Label Field Color, inch	Minimum Height of Letters, inch
0.75 – 1.25	8	0.5
1.5 - 2	8	0.75
2.5 - 6	12	1.25
8 -10	24	2.5
Over 10	32	3.5

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Colors: For air without any hazardous material, white letters on blue background. For air with toxic or corrosive content, black lettering on orange background.

C. Maximum Temperature: Able to withstand temperatures up to 160 deg F

D. Label and Lettering Size: To be in accordance with the table below:

Duct Width or Height Including Cover, inch	Minimum Length of Label Field Color, inch	Minimum Height of Letters, inch
Up to 6	12	1.25
7 to 10	24	2.5
Over 10	32	3.5

E. Fasteners: Stainless-steel rivets or self-tapping screws.

F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: [Brass, 0.032-inch]minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass [wire-link or beaded chain; or S-hook].

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches .
2. Fasteners: [Brass grommet and wire].
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

B. Color, Lettering, Design: To be in accordance with OSHA regulations and ANSI /ASME A13.1 (2007).

2.7 ACCESS IDENTIFICATION

A. Valves and equipment concealed above ceilings shall be identified with ceiling markers, Brady “Valve Finder Ceiling Tacks”, or acceptable equivalent. Ink, crayon or similar identification will not be acceptable. Locate markers on grids where acoustical hung ceilings are installed.

B. Markers:

1. Use colored markers with pressure sensitive adhesive on one side.
2. Make colored markers of paper of plastic, 6 to 9 mm (1/4 to 3/8 inch) in diameter.

C. Use markers of the same diameter throughout building.

D. Color Code: Use following color markers for service identification:

Color	**Service**
Red	Sprinkler System: Valves and Controls
Green	Domestic Water: Valves and Controls
Yellow	Chilled Water and Heating Water
Orange	Ductwork: Fire Dampers
Blue	Ductwork: Dampers and Controls
Black	Gas: Laboratory, Medical, Air and Vacuum

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in [Section 099123 "Interior Painting"].

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25 feet and at least once in every room.

C. Pipe Label Color Schedule:

1. Refrigerant Piping: For refrigerants in Safety Class A1 per ASHRAE Standard 34:

   a. Background Color: Black.
   b. Letter Color: White.

2. Refrigerant Piping: For refrigerants in Safety Classes other than A1, use the color scheme per ANSI/ASME A13.1 (2007) according to the hazard posed by them. Low-Pressure Steam Piping:

   a. Background Color: White.
   b. Letter Color: Black.

D. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.
2. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.

3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

1. For all ducts carrying air without hazardous content, white lettering on blue background.
2. ASME A13.1 (2007) Colors and Designs: For hazardous material exhaust.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:
   a. Refrigerant: 2 inches square.
   b. Gas: 2 inches square.

2. Valve-Tag Color:
   a. Refrigerant: (Safety Class A1) Black.
   b. Gas: Yellow.

3. Letter Color:
   a. Refrigerant: White.
   b. Gas: Black.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

TABLE OF CONTENTS
SECTION 230593 – TESTING, ADJUSTING, AND BALANCING FOR HVAC

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

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

B. Contract Documents Examination Report: Within 15 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports.

E. Sample report forms.

F. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by [AABC] [NEBB] [or] [TABB].

1. TAB Field Supervisor: Employee of the TAB contractor and certified by [AABC] [NEBB] [or] [TABB].
2. TAB Technician: Employee of the TAB contractor and who is certified by [AABC] [NEBB] [or] [TABB] as a TAB technician.

B. TAB Conference: Meet with Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Coordination and cooperation of trades and subcontractors.
d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by [Commissioning Authority].

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

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

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

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, [engage one of the following] [available TAB contractors that may be engaged include, but are not limited to, the following]:

1. Wings Testing and Balancing

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

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

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "[Metal Ducts] " and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
3. - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

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

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

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

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

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

O. Examine operating safety interlocks and controls on HVAC equipment.

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

3.3 PREPARATION

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

B. Complete system-readiness checks and prepare reports. Verify the following:

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

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in [AABC's "National Standards for Total System Balance",] [ASHRAE 111,] [NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems",] [SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing",] and in this Section.

1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

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

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

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

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

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

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

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

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

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

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

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

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

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

L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.6 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

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

3.7 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.8 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.9 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: [Plus or minus 10 percent].
2. Air Outlets and Inlets: [Plus or minus 10 percent].
3. Heating-Water Flow Rate: [Plus or minus 10 percent].
4. Cooling-Water Flow Rate: [Plus or minus 10 percent].

3.10 REPORTING

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

B. Status Reports: Prepare [biweekly] [progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.11 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

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

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

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.

b. Conditions of filters.
c. Cooling coil, wet- and dry-bulb conditions.
d. Face and bypass damper settings at coils.
e. Fan drive settings including settings and percentage of maximum pitch diameter.
f. Inlet vane settings for variable-air-volume systems.
g. Settings for supply-air, static-pressure controller.
h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.
b. Total system static pressure in inches wg.

c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

Apparatus-Coil Test Reports:

1. Coil Data:

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

2. Test Data (Indicated and Actual Values):

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

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Fuel type in input data.
    g. Output capacity in Btu/h.
    h. Ignition type.
    i. Burner-control types.
    j. Motor horsepower and rpm.
    k. Motor volts, phase, and hertz.
    l. Motor full-load amperage and service factor.
    m. Sheave make, size in inches, and bore.
    n. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

    a. Total air flow rate in cfm.
    b. Entering-air temperature in deg F.
    c. Leaving-air temperature in deg F.
    d. Air temperature differential in deg F.
    e. Entering-air static pressure in inches wg.
    f. Leaving-air static pressure in inches wg.
    g. Air static-pressure differential in inches wg.
    h. Low-fire fuel input in Btu/h.
    i. High-fire fuel input in Btu/h.
    j. Manifold pressure in psig.
    k. High-temperature-limit setting in deg F.
    l. Operating set point in Btu/h.
    m. Motor voltage at each connection.
    n. Motor amperage for each phase.
    o. Heating value of fuel in Btu/h.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and size.
    e. Manufacturer's serial number.
    f. Arrangement and class.
    g. Sheave make, size in inches, and bore.
    h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

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

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

    a. System and air-handling-unit number.
    b. Location and zone.
    c. Traverse air temperature in deg F.
    d. Duct static pressure in inches wg.
    e. Duct size in inches.
    f. Duct area in sq. ft..
    g. Indicated air flow rate in cfm.
    h. Indicated velocity in fpm.
    i. Actual air flow rate in cfm.
    j. Actual average velocity in fpm.
    k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:

1. Unit Data:

    a. System and air-handling unit identification.
    b. Location and zone.
    c. Apparatus used for test.
    d. Area served.
    e. Make.
    f. Number from system diagram.
    g. Type and model number.
    h. Size.
    i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

    a. Air flow rate in cfm.
    b. Air velocity in fpm.
    c. Preliminary air flow rate as needed in cfm.
    d. Preliminary velocity as needed in fpm.
    e. Final air flow rate in cfm.
    f. Final velocity in fpm.
    g. Space temperature in deg F.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

    a. System and air-handling-unit identification.
    b. Location and zone.
    c. Room or riser served.
    d. Coil make and size.
    e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

    a. Air flow rate in cfm.
    b. Entering-water temperature in deg F.
    c. Leaving-water temperature in deg F.
    d. Water pressure drop in feet of head or psig.
    e. Entering-air temperature in deg F.
    f. Leaving-air temperature in deg F.

L. Instrument Calibration Reports:

1. Report Data:

2. :

    a. Instrument type and make.
    b. Serial number.
    c. Application.
    d. Dates of use.
    e. Dates of calibration.

3.12 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:

    a. Measure airflow of at least [10] percent of air outlets.
    b. Measure water flow of at least [5] percent of terminals.
    c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
    d. Verify that balancing devices are marked with final balance position.
    e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by [Commissioning Authority].
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of [Commissioning Authority].
3. [Commissioning Authority] shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. rements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
3. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.13 ADDITIONAL TESTS

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

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

END OF SECTION 230593

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SECTION 230713 – DUCT INSULATION

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Outdoor, concealed supply and return.
4. Outdoor, exposed supply and return.

B. Related Sections:

1. Division 23 Section "HVAC Equipment Insulation."
2. Division 23 Section "HVAC Piping Insulation."
3. Division 23 Section "Metal Ducts" for duct liners.

1.3 SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

C. Qualification Data: For qualified Installer.

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

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 COORDINATION

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

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

1.7 SCHEDULING

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

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

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

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

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

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

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

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; Commercial Board.
b. Fibrex Insulations Inc.; FBX.
c. Johns Manville; 800 Series Spin-Glas.
d. Knauf Insulation; Insulation Board.
e. Manson Insulation Inc.; AK Board.
f. Owens Corning; Fiberglas 700 Series.

2.2 ADHESIVES

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

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers; CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster; 85-60/85-70.
d. Mon-Eco Industries, Inc.; 22-25.

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.
6. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
7. Service Temperature Range: 0 to 180 deg F.
8. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
9. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers; CP-10.
    b. Eagle Bridges - Marathon Industries; 550.
    c. Foster; 46-50.
    d. Mon-Eco Industries, Inc.; 55-50.
    e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers; CP-50 AHV2.
    b. Foster; 30-36.
    c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers; CP-76.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster; 95-44.
    d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

B. ASJ Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following:

a. Childers; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.

1. Products: Subject to compliance with requirements, provide the following:

a. Childers; Chil-Glas No. 5.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster; Mast-A-Fab.
b. Vimasco Corporation; Elastafab 894.

2.8 FIELD-APPLIED CLOTHS

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

1. Products: Subject to compliance with requirements, provide the following:

a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 428 AWF ASJ.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
c. Compac Corporation; 104 and 105.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.10 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.

3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated.

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) AGM Industries, Inc.; CWP-1.
        2) GEMCO; CD.
        3) Midwest Fasteners, Inc.; CD.
        4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) AGM Industries, Inc.; CHP-1.
        2) GEMCO; Cupped Head Weld Pin.
        3) Midwest Fasteners, Inc.; Cupped Head.
        4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
        2) GEMCO; Perforated Base.
        3) Midwest Fasteners, Inc.; Spindle.

    b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    c. Spindle: Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
    d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) AGM Industries, Inc.; RC-150.
        2) GEMCO; R-150.
        3) Midwest Fasteners, Inc.; WA-150.
        4) Nelson Stud Welding; Speed Clips.

    b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

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

1. Manufacturers: Subject to compliance with requirements, provide the following:

    a. C & F Wire.

2.11 CORNER ANGLES

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

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

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

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

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

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

F. Keep insulation materials dry during application and finishing.

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

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

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

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

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

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

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

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

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

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

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07 Section "Penetration Firestopping "firestopping and fire-resistive joint sealers.

D. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FINISHES

A. Insulation with ASJ, Glass-Cloth or other jacket material that is not manufacturer approved for painting:

1. Painting of insulation jacket materials is prohibited.

B. Insulation with Manufacturer Approved Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

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

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

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

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

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply, return and outdoor air.
2. Indoor, exposed supply and outdoor air.

3. Outdoor, concealed supply and return.
4. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, supply-air & return air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

B. Concealed, outdoor-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

C. Concealed, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be the following:

1. Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

D. Exposed, rectangular, outdoor-air duct insulation shall be one of the following:

1. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

E. Exposed, rectangular, exhaust-air duct insulation between the outdoors and damper shall be one of the following:

1. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

3.10 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

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

B. Concealed, round, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 3 inches and 3-lb/cu. ft. nominal density.

C. Concealed, rectangular, supply-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 3 inches and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

D. Concealed, rectangular, return-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 3 inches and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

E. Exposed rooftop, rectangular, supply-air duct insulation shall be one of the following:

1. Polyiso board 2” with venturclad jacket. Top sheet of insulation to be pitched 1/4” per foot to shed rain/snow.

F. Exposed rooftop, rectangular, return-air duct insulation shall be one of the following:

1. Polyiso board 2” with venturclad jacket. Top sheet of insulation to be pitched 1/4” per foot to shed rain/snow.

3.11 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

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

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

C. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Self-adhesive outdoor jacket.

D. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Self-adhesive outdoor jacket.

END OF SECTION 230713

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SECTION 230719 – HVAC PIPING INSULATION

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:
   1. Refrigerant suction and hot-gas piping, indoors and outdoors.

B. Related Sections:

   1. Division 23 Section "HVAC Equipment Insulation."
   2. Division 23 Section "Duct Insulation."

1.3 SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at pipe expansion joints for each type of insulation.
   3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   4. Detail removable insulation at piping specialties.
   5. Detail application of field-applied jackets.
   6. Detail application at linkages of control devices.

C. Qualification Data: For qualified Installer.

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

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 COORDINATION

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

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

1.7 SCHEDULING

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," and "Outdoor, Aboveground Piping Insulation Schedule," articles for where insulating materials shall be applied.

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

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

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

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

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

2.2 ADHESIVES

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

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers; CP-97.
b. Eagle Bridges - Marathon Industries; 290.
c. Foster; 81-27.
d. Mon-Eco Industries, Inc.; 22-30.
e. Vimasco Corporation; 760.

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.
e. Speedline.
f. Johns Manville.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. Speedline Corporation; Polyco VP Adhesive.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers; Encacel.
    b. Eagle Bridges - Marathon Industries; 570.
    c. Foster; 60-95/60-96.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers; CP-10.
    b. Eagle Bridges - Marathon Industries; 550.
    c. Foster; 46-50.
    d. Mon-Eco Industries, Inc.; 55-50.
    e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers; CP-50 AHV2.
    b. Foster; 30-36.
    c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers; CP-76.
b. Eagle Bridges - Marathon Industries; 405.
c. Foster; 95-44.
d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2.7 FIELD-APPLIED JACKETS

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

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

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Johns Manville; Zeston.
b. Pag Industries.
c. Proto Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers; Metal Jacketing Systems.
b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Factory cut and rolled to size.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

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

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Polyguard Products, Inc.; Alumaguard 60.
    b. Childers.
    c. Venture-Clad

2.8 VALVE WRAPS

A. Valve Wraps: Flexible insulation system, removable and reusable wraps shall be used over an insulated valve and secured with Velcro closure.

1. Products: Subject to compliance with requirements, provide the following:

    a. NO SWEAT

2. Color: White.

3. Factory-fabricated valve covers to coincide with valve size and piping application.

    a. Hot Systems:
        1) For use at temperatures at or below 200°F.
        2) For use at temperatures above 250°F or where pipe insulation is greater than 1-1/2”, two or more layers of insulation inserts are required beneath valve cover surface.
    b. Cold Systems:
        1) For use at temperatures below 45°F or where pipe insulation is greater than 1-1/2”, two or more layers of insulation inserts are required beneath valve cover surface.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ABI, Ideal Tape Division; 428 AWF ASJ.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    c. Compac Corporation; 104 and 105.
    d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.

7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 370 White PVC tape.
b. Compac Corporation; 130.
c. Venture Tape; 1506 CW NS.
d. Johns Manville Zeston Z-Tape.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

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

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. C & F Wire.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

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

3.3 GENERAL INSTALLATION REQUIREMENTS

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

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

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

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

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

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

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

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

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

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

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

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

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

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

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

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

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

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

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

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

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

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

D. Install removable insulation covers at locations required. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over

adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

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

3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth or other jacket material that is not manufacturer approved for painting:

1. Painting of insulation jacket materials is prohibited.

B. Insulation with Manufacturer Approved Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

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

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

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

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

3.10 PIPING INSULATION SCHEDULE, GENERAL

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

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 2 inches thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

B. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 2 inches thick.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

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

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

C. Piping, Exposed:

1. Aluminum, Smooth with Z-Shaped Locking Seam: 0.032 inch thick.

END OF SECTION 230719

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SECTION 230800 – COMMISSIONING OF HVAC

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 ALLOWANCES

A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Division 01 Section "Allowances."

1.5 UNIT PRICES

A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Division 01 Section "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

1.6 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.7 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.8 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing, adjusting, and balancing reports.

1.9 SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 Testing AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least [10] days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1. The CxA will notify testing and balancing [Contractor] [10] days in advance of the date of field verification. Notice will not include data points to be verified.
2. The testing and balancing [Contractor] [shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC&R [Contractor], testing and balancing [Contractor] , and HVAC&R Instrumentation and Control [Contractor] shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in Division 23 boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.

B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls." Assist the CxA with preparation of testing plans.

C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC&R [**Contractor**] shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of natural gas and hot water systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

F. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

G. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION 230800

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SECTION 230940 – HVAC INSTRUMENTATION AND CONTROLS

SECTION 230940 – HVAC INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems and equipment.

B. Manufacturers:

1. Acceptable manufacturers of electronic and DDC controls are Honeywell, Distec & Trane (Lynx-spring).
2. Other manufacturers will NOT be considered unless specifically requested in writing and specifically approved by the Engineer.

1.3 SCOPE

A. Contractor shall either expand existing Honeywell controls system located in adjacent building or provide new stand alone controls package with new head end by Distec or Trane. New control system shall convert all existing pneumatic control points to digital and control all new equipment shown on contract documents. A site visit is required to verify the scope of existing pneumatic control points.

B. Provide labor, materials, services, equipment and transportation necessary for complete and operational system of automatic temperature control and building management (i.e., DDC system), as indicated on Contract Drawings and specified herein, including, but NOT limited to, the following:

1. Controls for air systems including supply fans, heating coils, cooling coils, humidifiers, return fans, exhaust fans and dampers.
2. Controls for space heating systems including direct radiation, convectors, unit heaters.
3. Controls for heating hot water plant including water heater, circulating pumps and valves.
4. Controls for service hot water plant including water heater, circulating pumps and valves.
5. Heat recovery system controls.
6. Control piping.

7. Removal and/or relocation of existing thermostats to accommodate work, as required and as shown.
8. Checking, servicing, adjusting and putting in proper operating condition: existing controls (such as duct pressure controls and dampers) in systems affected by the Work, so that new and existing components work together to produce the required results.
9. Furnishing of automatic control valves and dampers, pressure sensors and sensor wells to be installed under Division 23.
10. Building Management System including:
    a. Control of mechanical systems
    b. Monitoring
    c. Alarm
    d. Energy Management
    e. Energy use reporting
    f. Calculation of data for custom reports
    g. Color graphics of floor plans and mechanical systems
    h. Totalization logs
    i. Historical trend logs
11. Fire dampers, volume dampers and control dampers.
12. Smoke dampers.
13. Combination fire/smoke dampers.
14. Sleeves, escutcheons, seals, waterproofing and similar devices.
15. Thermometers.
16. Pressure gauges.
17. Utility rebate motors for all applications, unless noted otherwise.
18. High efficiency motors for all applications unless noted otherwise.
19. Standard motors for all applications unless noted otherwise.
20. Motor starters.
21. Painting as required under Division 23.
22. Hangers, anchors, guides, bases and other supports.
23. Access panels and access doors.
24. System identification, including valve tags.
25. Noise and vibration control.
26. Seismic restraints, including equipment bolts and welding.
27. Cleaning, lubrication, testing, balancing and adjusting.
28. Coordination drawings.
29. Record drawings.
30. Operating and Maintenance Manuals.
31. Instructions.

1.4 SHOP DRAWINGS AND OTHER SUBMITTALS

A. Make preliminary submittal of two sets of Pneumatic and Electric control drawings to Engineer for review before shop drawings are submitted through normal channels. The purpose of this preliminary submittal is to save time. Include the following information:

1. Temperature control ranges
2. Spring pressure ranges
3. Transducer ranges
4. Method of control
5. Control devices selected
6. Description of operation

B. Submit, for review, shop drawings for each item of material, equipment and system component furnished or installed as part of the work of this Section. Shop drawing requirements are specified under SECTION 230010, GENERAL REQUIREMENTS FOR MECHANICAL WORK and under DIVISION 1.

C. Shop drawings shall include control layout and data on sensitivity, pressure ranges, temperature ranges, means of adjustment, means of calibration, spring ranges and other data necessary for review of each device, its function and its intended application.

D. Devices on shop drawings shall be identified by numbers and letters. These identifiers shall also be used in description of operation, in control layouts and on data sheets for ease in cross-referencing.

E. Shop drawings shall include motor efficiency data for three-phase motors 1 HP and larger.

F. Submit circuit coordination information for review by Engineer and Contractor, indicating circuit requirements by electrical panel, i.e., panel identification and maximum load of each circuit required for control system. Submittal will be returned indicating Engineer's final determination of panels and circuits to be used.

1. Furnish copy of final circuit determinations to DIVISION 26 Contractor, for use in preparing panel directories. Information on circuits shall include control component and area served.

G. Furnish certificate from manufacturer of control system that expansion hardware and software shall be available for next 10 years.

H. Furnish ASME certified test certificates for receiver tank on air compressor.

I. Furnish instruction manual for review. Manual shall describe function and operation of all control and management system components and shall include trouble-shooting and operating procedures. Manual shall be easily understood, for use by Owner's personnel; shall show the total integrated control system; and shall include:

1. System description.
2. Control devices, including number, system, service, location and normal position of each.
3. Information on sequencing of related devices.
4. Calibration charts and instructions.

J. Submit software manual to Owner for review. Software manual shall describe programming and testing, including:

1. System overview and detailed description of each software feature.
2. Instructions for user operation, including verifying status and errors, changing passwords, and initiating or disabling control programs.
3. Description of programming language including commands, editing and writing control programs, algorithms, printouts and logs, mathematical calculations and passwords.
4. Copies of application program software and documentation necessary for Owner to interpret program and make any changes desired.
5. Instructions for user programming or reprogramming any portion of DDC system including control programs, algorithms, mathematical equations, variables, setpoints, time periods, messages and other information necessary to load, alter, test and execute DDC system.
6. Reference summary sheets, which compare control programs with pertinent information about hardware and field wiring information.
7. Point identification including terminal number, symbol, engineering units and control program reference number.
8. Field information including DDC system hardware and locations, device type and function, electrical parameters and record drawing reference numbers.

K. Submit data summary forms to Owner for review. Forms shall define following information, for inclusion into DDC system, for each point in DDC system.

1. Description of each piece of equipment and the functions to be controlled.
2. For each DDC system function, a listing of digital and/or analog hardware required to interface DDC system to equipment.
3. Listing of digital and analog alarms.
4. Listing of DDC system application programs associated with each piece of equipment. This listing shall include control algorithms and mathematical equations and shall be in easy-to-understand English format.

L. Upon completion of project, submit for review pneumatic control and electric control shop drawings corrected for “as-built” conditions. Shop drawings shall include final pressure settings, spring ranges, temperature ranges, throttling ranges and temperature control settings. Three copies of accepted “record” shop drawings shall be furnished to Architect.

1.5 COORDINATION DRAWINGS

A. Before materials are purchased or work is begun, prepare Coordination Drawings showing size and location of mechanical pipes, ducts, equipment and appurtenances, relative to work of other trades.

B. Submit for review coordination drawings signed by following trades: sheet metal, plumbing, fire protection, electrical and other HVAC trades. Drawings shall be composite construction floor plans, developed and submitted electronically.

C. Preliminary coordination drawings shall be prepared as follows:

1. First: Sheet metal trade shall prepare coordination drawings, minimum ¼" = 1' scale, to be used as composite construction floor plans for coordination of trades. Plans shall show floor and ductwork layouts in detail, including ceiling heights, duct heights and sizes (including insulation), registers and diffusers, and light fixtures.
2. Second: As part of work of Division 21, fire protection trade shall draw fire protection piping, etc., on coordination drawings prepared by sheet metal trade.
3. Third: As part of Division 26, Electrical Work, electrical trade shall draw electrical distribution conduits, wires, panels and other electrical work, which must be coordinated with other trades; on coordination drawings which have been prepared by fire protection trade.
4. Fourth: As part of work on Division 23, plumbing trade shall draw waste piping, vent piping, water piping, risers and other plumbing work which must be coordinated with other trades; on coordination drawings which have been prepared by electrical trade.
5. Fifth: As part of work of Division 23, HVAC trades shall draw HVAC piping work which must be coordinated with other trades; on coordination drawings which have been prepared by plumbing trade.
6. Each trade shall use a different color code.

D. Coordination Meeting and Drawing Revisions:

1. Sixth: Contractor shall hold a coordination meeting with sheet metal, HVAC, fire protection, electrical and plumbing trades and shall resolve conflicts between trades. Coordination drawings are to assist in identifying trade conflicts.
2. Seventh: Sheet metal trade shall revise coordination drawings to reflect revisions to the various trade work (including sheet metal, HVAC, fire protection, electrical and plumbing trades), as determined by coordination meeting.
3. Eighth: Sheet metal, HVAC, fire protection, electrical and plumbing trades shall sign the revised coordination drawings as indication of their acceptance of the construction layout shown thereon.

E. Sheet metal trade shall submit the revised coordination drawings to Architect for review.

F. Coordination Drawings are for Contractor's and Engineer's use during construction and shall not be construed as replacing shop, "as-built" or record drawings required elsewhere in the Contract Documents.

1.6 CONTRACTOR QUALIFICATION REQUIREMENTS

A. Demonstrate capability to execute this Contract by submitting evidence of following:

1. Minimum of five years, actively engaged in the business of installing control and automation systems.
2. Manufacturer's approved service facilities, located within the area covered by the installing office.

B. As requested, submit catalog data and letters or certificates from Owners of other buildings in which similar control systems have operated successfully as intended.

1.7 SERVICES

A. Provide necessary service, adjusting and checking of control and management systems, at no additional cost to the Owner, during 12-month period of guarantee.

1. This shall include service required to correct space temperature alarms and equipment control problems which are the result of control component malfunctions.
2. This shall NOT include service required to correct failure of mechanical equipment being controlled.
3. This shall include full system checkout and calibration during the 12th month of guarantee period.

B. Furnish service contract for Owner's consideration, which continues systems' service beyond the guarantee period. This is NOT part of the Construction Contract and is an extra cost to the Owner, at Owner's option.

1.8 INSTRUCTION TRAINING

A. Competent technicians shall provide 8 hours of instruction to the Owner's personnel. Instructions shall include, but are NOT limited to, the following:

1. Familiarization with HVAC Control system, hardware and operation procedures.
2. Familiarization with Management System Hardware.
3. Use of management system.
4. Modifications of software packages.
5. Trouble-shooting and service procedures.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM – GENERAL REQUIREMENTS

A. All equipment shall be by one manufacturer, insofar as possible. Unless specified otherwise, equipment shall be fully modulating and state-of-the-art.

B. Contract Drawings do NOT show every control device and every location. It shall be understood that Specifications are the primary guide to control requirements and that, unless specifically excluded, every piece of heating and cooling equipment shown on Contract Drawings requires controlling device.

C. Control system shall be complete in all respects including:

1. Room, insert and immersion thermostats and sensors.

2. PE and EP switches.
3. Transmitters.
4. Relays.
5. Valves.
6. Dampers.
7. Air compressor assembly and refrigerated air dryer.
8. Control panels.
9. Electronic analog sensors: temperature, humidity, pressure, flow and/or others as required.
10. Digital controllers.
11. Central monitoring terminal (CMT).
12. Transmission power supply.
13. Operators' terminal and printer.
14. Air piping.
15. Pneumatic control piping.
16. Control wiring.
17. Auxiliary devices and accessories.
18. Interface with fire alarm system.
19. Modem/telephone interface and associated software.

D. Electronic monitoring system shall be UL listed or ETL approved.

E. Insofar as possible:

1. Sequencing shall be accomplished by selection and application of proper spring ranges to damper operators and valve operators; pilot positioners shall NOT be used in lieu of proper spring range selection.
2. Ranges and sensitivities of master controllers shall be selected to eliminate need for submaster controllers.

F. Provide power and control wiring, conduit, junction boxes, fittings and other electrical appurtenances that are required for complete and operational control and monitoring systems; conform to electrical standards, codes and requirements specified under DIVISION 26, ELECTRICAL WORK. This work shall include:

1. Wiring of control and monitoring devices and circuits carrying voltages up to and including 120 Volt, unless otherwise indicated.
2. Wiring of 120 VAC power feeds to temperature control panels, CPU, digital controllers, printer and other control system equipment.
3. Wiring required for interfacing with building fire alarm, security and emergency generator systems; including wiring between DDC panels and fire alarm system panels.
4. Wiring of control system including wiring from sensors to panels, wiring from panels to CPU, and wiring from CPU to operator's terminal.
5. Wiring to "Auto" side of hand-off-auto switches on units being controlled as part of work of this Division.

6. Wiring of devices controlled as part of the work of this Division, whether furnished under this Division or another Division. Examples of devices include: alarm device, relay, solenoid valve, actuator and electro-mechanical device at control cabinet.
7. Wiring of devices providing control inputs, whether furnished under this Division or another Division. Examples of devices include: smoke detector contact; fire alarm relay contact; pressure, temperature, limit level and motion switches; PE switch and analog sensor.
8. Wiring from temperature control panel to terminal strips.
9. Wiring between panel terminal strips and field-mounted devices.
10. Wiring from modems and alarm dialers to telephone jacks. Coordinate with Owner's telephone contractor.

G. For bidding purposes, unless otherwise indicated, closest appropriate electrical panel shall be assumed to have circuit(s) available for control system use. Coordinate selection of circuits for control system use, by special submittal; refer to paragraph 1.4.F where mechanical equipment is designed to operate on standby power during utility outages, derive all control power for end devices and panels/CPU from a standby power source.

H. Control and monitoring devices that are part of an engineered smoke control system shall be provided with emergency power.

I. Power wiring installed and terminated as part of the work of DIVISION 26, ELECTRICAL WORK, shall include:

1. Wiring of devices and circuits carrying voltages GREATER than 120 Volts, unless otherwise indicated.
2. Wiring of power feeds to disconnects, starters and electric motors.
3. Installation of, and wiring of line power to, fused disconnects for each air compressor.
4. Wiring from disconnects to equipment motor starters.
5. Wiring from equipment motor starters to equipment motors.

2.2 TRANSMISSION NETWORK

A. Automatic system shall have multi-drop digital transmission network that provides communication link between operator's terminal and all DDC panels.

B. System shall have error checking feature to ensure signal reliability and shall identify signal transmission network failures. System shall ensure signal quality and strength. System shall support multiple multi-drop trunks.

1. All multi-drop trunks shall be interfaced to the system via standard EIA interface.
2. When used with modems, multi-drop trunk shall interface to unconditioned voice-band 3002 telephone lines for remote building tie-in to automation system.

C. Transmission network shall be run in conduit or shall be shielded cable. Wiring shall NOT be run in same conduit with fire alarm, security, lighting, building power or other dedicated systems.

D. Transmission network speed shall be minimum 9600 baud rate.

2.3 CONTROL DAMPERS

A. Provide control dampers for each fan system, to allow effective modulation or close-off of air flow as required.

1. Dampers shall be low leakage design, with seals along both edges and ends of damper blades to provide tight closure. Air leakage of damper when in closed position shall NOT exceed 1% of system design volume at 1" w.g. differential pressure.
2. Dampers shall be sized for design velocities of 1500 fpm through free area of damper at maximum system air flows.
3. Two-position dampers shall have parallel blade linkage; modulating dampers shall have opposed blade linkage. Dampers shall be arranged for normally open or normally closed operation, as required. Linkage shall be serviceable without removal of entire damper.
4. Damper construction shall be suitable for damper operation at maximum fan pressure, without failure, binding or distortion.

B. Damper frames shall be either galvanized steel or aluminum, constructed to facilitate field assembly. Frames shall have openings or mounting clips which allow secure fastening of frame to surrounding ductwork, duct collar or fan housing.

C. Damper blades shall be either galvanized steel or aluminum, with maximum blade length of 48" in any section. Blades shall have suitable bearings for smooth operation and shall be interconnected to provide unison operation.

D. Provide stiffening or bracing for frame sections over 48" high.

E. Outdoor air dampers shall have separate minimum and maximum sections.

F. Provide insulated damper blades on outside air plenums, dog house louvers, etc., that do not have ductwork connected.

2.4 DAMPER ACTUATORS

A. Motor actuators shall have non-overloading motors, and shall be direct drive by Belimo or acceptable equivalent. Actuators shall have moisture- and corrosion-resistant construction suitable for the environment in which they are installed.

B. Actuator sizing and quantity shall be determined by control manufacturer:

1. As needed to meet system requirements.
2. As needed to provide sufficient power for smooth modulation over entire range.
3. As needed to be able to open or close damper without binding or damage, at pressure differential up to 4" w.g. for low pressure systems and up to 8" w.g. for medium and high pressure systems.

C. Provide actuator for each damper over four feet in length or height.

D. Each actuator shall be matched to the type of analog output available from the controller and shall have a matching control range.

E. Assembly shall include necessary mounting hardware and brackets.

F. Motors at outdoor air ducts (intake and exhaust) and motors interlocked with them shall have a power-fail safety device which return motors to their normal position.

G. Where required, provide end switches and/or feedback potentiometer to report actuator position.

H. Damper operators for packaged terminal air control devices are specified under Division 23.

I. For terminal units: Control valve pressure drops should be minimum of 10 feet, may be up to 25% of pump head on small systems and may be up to 15-20% of pump head on large systems.

J. For mechanical room units (close to pump), when only system piping is within mechanical room: Control valve pressure drops may be lower to limit pump head (2-12 foot range, or 1-5 psig). If total system head is greater than 45 feet, use 50% of this head for valves near the pump (e.g. 22 ft) and 25% for furthest valves (e.g. 11 ft).

K. If system uses only 3-way control valves: Control valve pressure drop is not as critical and may be lower than for 2-way valve system.

L. Check proper close-off pressure with Engineer or Principal.

M. You should always allow for at least a 10 ft control valve drop when sizing the pump.

2.5 AUTOMATIC CONTROL VALVES - GLOBE/PLUG TYPE

A. Provide automatic temperature control valves for services as indicated on Contract Drawings. Valves shall be normally open, normally closed or mixing type, as required. Unless otherwise noted, valves shall be as follows:

1. Valves 2" and smaller: Globe valve, 250# WOG, 150# WSP, bronze body, screwed ends.
2. Valves 2-1/2" and larger: ANSI Class 150, steel body, bronze trim, flanged ends.

B. Valve design shall allow disassembly of valve top, inspection and replacement of packing without system shutdown or valve body removal.

C. Provide following accessories:

1. Valve stem packing: low friction, tight sealing, of material and pressure rating suitable for service.
2. Valve stems of polished stainless steel or Monel, for valves 2-/12" and larger.

3. Valve actuators: suitable and sized for closing against system differential pressure; with proper spring ranges to facilitate sequencing application (pneumatic).

D. Provide hot water radiation valves:

1. Of compact modulating design, bronze or forged brass body, with ports sized to provide accurate control under any load condition.
2. With valve tops sized to fit within radiation enclosures.
3. With maximum hot water pressure drop through valve of 2 psig.

E. Provide hot water coil valves & chilled water coil valves:

1. In general, valves shall be two-way modulating type, equal percentage valves with throttling plug, selected to have pressure drop between 4 psig and 6 psig at maximum design flow.
2. Where indicated, valve shall be three-way modulating type, equal percentage valve with throttling plug, selected to have pressure drop between 2 psig and 5 psig at maximum design flow.
3. Valves shall have close-off rating suitable for minimum differential pressure of 60 psig. Insofar as possible, valves on same pump system shall have approximately same pressure drop. Higher pressure drops are permitted on valves nearest to pump (up to 50% of system pressure drop on systems with total pump head over 45 feet).
4. Hot water coil valves shall be normally open to coil. Operators shall be coordinated with cooling coil valves so that both coils CANNOT be activated simultaneously.
5. Chilled water coil valves shall be normally closed to coil. Operators shall be coordinated with heating coil valves so that both coils CANNOT be activated simultaneously.

F. Reheat water valves shall be normally closed to coil or shall be floating control type which remains at last position.

2.6 ROOM AND DUCT HYGROSTATS

A. Hygrostats shall be gradual acting with ambient temperature compensation. Hygrostat shall have highly sensitive hygroscopic element, with adjustable setpoint and sensitivity.

1. Sensitivity shall be adjustable from 1/4 to 4 psi per 1% RH.
2. Control range shall be 20 to 80% RH with 1/4% RH response.

2.7 THERMOMETERS

A. Unless otherwise specified, local thermometers for central air system shall be provided under Division 23.

2.8 ELECTRONIC TRANSMITTERS AND SENSORS

A. Electronic Temperature Transmitters: shall be solid state; RTD, thermistor or IC type which transmit electric analog signal to DDC panel; shall have proper range and accessories to transmit temperature value to DDC panel with accuracy of +/-1°F; shall be field calibrated, wired between point of sensing and DDC panel.

B. Space Temperature Sensors: shall be thermistor RTD or IC type; with cover of brushed aluminum or as accepted by Architect; with locking vandal-resistant guards keyed alike.

C. Sensors for outdoor shall have suitable radiation shield and weatherproof enclosure. Outdoor air temperature sensor shall be RTD type with platinum element.

D. Sensors to measure discharge and return air duct temperatures shall use single point sensing. Sensor to measure mixed air temperatures shall be averaging type with minimum 20-foot capillary element or averaging probe type.

E. Pipe Immersion Temperature Sensors: shall have stainless steel immersion well and accessories. When installed on inlet and outlet of heat exchanger, sensors shall be selected from the same manufacturing run, certified to read within +/-0.1°F of each other.

F. Space or Duct Relative Humidity Sensors: shall be accurate to +/-3% when compared to accurate reference psychrometer, from 20% RH to 80% RH.

G. Low Pressure Transmitters for liquid differential pressure:

1. Transmitters shall have accuracy of +/-0.25%; shall be capable of withstanding system pressure applied to one port with no pressure on other port; shall be Setra #228, Viatran #323, Mamac #PR-284 or acceptable equivalent by Rosemont or Omega.
2. Provide three-valve manifold to simplify calibration. Provide mounting suitable to relieve stress on tubing and sensing transducer.
3. For differential pressures greater than 1.5 psi and low static head, Robinson-Halpern #150 is acceptable substitution.

H. Analog sensors shall be compatible with systems specified, carefully selected for the required span.

I. All sensor wiring - analog or digital, input or output - shall be capable of sharing single conduit runs without affecting signal performance. Sensor wiring shall be capable of sharing single conduit runs with switched 120 VAC or 240 VAC. If this is NOT possible, provide separate conduits for sensor wiring, to ensure signal integrity.

2.9 SMOKE DETECTION

A. As part of work of DIVISION 26, ELECTRICAL WORK: Furnish two smoke detectors for each air system rated above 2,000 cfm and for each air system so indicated on Contract Drawings.

B. Installation of smoke detectors in the air systems, (first) one on discharge side of supply fan and (second) one in return/exhaust airstream, shall be done as part of work of SECTION 230880, BASIC MATERIALS - AIR DISTRIBUTION.

C. As part of work of this Section, provide wiring from smoke detectors to DDC system so that, when a detector serving a particular system senses smoke, DDC system shall:

1. Indicate alarm condition at DDC system console.
2. Stop that system's supply, return and exhaust fans.
3. Close that system's outside air intake and exhaust dampers.
4. For systems with supply air quantity of 15,000 cfm or more: Close that system's return air damper and discharge fire/smoke damper.

D. Detector installation and control action shall be strictly in accordance with NFPA 90A.

2.10 CONTROL PANELS

A. Control panels shall be fully enclosed, all metal construction. Panels shall have hinged door with full piano hinges or heavy duty concealed hinges, with locking latch or bolt-on cover plate and with work light and switch. All panel locks shall be common keyed. Panels shall be finished with two coats of enamel paint.

B. Indicating devices and manual adjustment devices required for routing operation of system shall be located on panel door or cover plate. Other devices shall be located on sub-panel within panel.

C. Panels shall have ample room for control device mounting and wiring.

D. Panels shall house control apparatus, relays, I-P transducers, EP and PE switches, gauges, and other items required to implement the control sequence.

E. Panel shall display: discharge air temperature, return air temperature, mixed air temperature, outdoor air temperature, and alarm lights.

2.11 SYSTEM SOFTWARE AND GRAPHICS

A. Provide software required for efficient operation of functions required. Software shall be modular in design with flexibility in expansion and revision of the system. Software shall include, as a minimum:

1. Complete database entry.
2. Configuration of application programs to provide the sequence of operation indicated.
3. Graphics of each system as shown on the I/O Summary Table.
4. Alarm limits and alarm messages for critical and non-critical alarms.
5. Configuration of reports and point summaries indicted.
6. Capability for graphic programming.

B. Software package shall display graphically, in different colors, the following system information:

1. General area maps, showing locations of controlled buildings in relation to local landmarks.
2. Floor plan maps, showing heating and cooling zones throughout the buildings. Colors shall provide visual display of temperature relative to zone's respective setpoints. Colors shall be updated dynamically as the zones' comfort conditions change. Setpoint adjustment and color band displays shall be provided as specified in paragraph 3.02.D.5 "Setpoints".
3. Mechanical system graphics, showing the type of mechanical system components serving each zone, by use of pictorial representation of components. Graphic shall provide current status of I/O points being controlled, as applicable to each piece of equipment, including analog readouts in appropriate engineering units, at appropriate locations on the graphic.

C. Each category of software shall consist of interactive software modules. Each module shall have an associated priority level and shall execute as determined by the program controller as defined in the real-time operating system.

D. Software package shall allow receipt of alarms and messages while in a functional mode other than energy management, i.e., incoming alarms shall be displayed while the operator is in word processing, spreadsheet or other operating mode. System must automatically: switch from non-energy management mode, respond to an alarm, and return to the exact position left in the previous functional mode.

E. Operator must be able to communicate and direct control functions through the use of two-button "mouse" operator interface to monitor and control functions and sequences within the system.

F. System shall operate on a "System" Format basis, regardless of the manner or hardware configuration in which the data is acquired. A "system" shall consist of a logical grouping of data points, related to a piece of mechanical equipment, an energy distribution system, or an architectural area. Output displays, logs of a point and logs of a group of points shall contain following information:

1. Graphic presentation of the system
2. User name of point
3. Point descriptor
4. Current value/status
5. Associated engineering units
6. Alarm description

G. System shall have capability to display setpoints and variables for each zone graphically. System shall allow setpoints to be changed in the graphics mode. System shall update the variable display continuously.

H. DDC/EMS shall be programmed to provide separate color graphic for:

1. Each piece of equipment being monitored or controlled
2. Each floor and zone being controlled
3. Each schedule
4. Each trend
5. Each report

I. Operator sign-on shall require as a signable password. System shall have up to 32 passwords, each of which may be one of six levels of system access.

J. Power Failure/Automatic Restart at the Control Module

1. Power failure shall cause the control module to go into an orderly shutdown with no loss of program memory.
2. Upon resumption of power, control module shall automatically restart and shall print out the time and date of power failure and of power restoration, at the respective central site system.
3. Restart program shall automatically restart affected field equipment. Operator shall be able to define an automatic power-up time delay for each piece of equipment under control.

K. Changes to database and program shall be done using standard procedures and shall be capable of being done while the system is on-line and operational. System shall allow changes to be made at the local site through a portable computer. System shall permit the operator to perform the following:

1. Add and delete points.
2. Modify point parameters.

L. Graphics software shall permit the easy construction of infinitely variable shapes and sizes through the use of the mouse pointing device. Graphics software shall be fully implemented and operational to accomplish the following:

1. Create a new graphic picture
2. Modify a portion of a graphic picture
3. Delete a graphic picture
4. Delete a portion of a graphic picture
5. Call up a graphic picture
6. Cancel the display of a graphic picture
7. Assign conditions which automatically initiate the display
8. Overlay alphanumerics and graphics
9. Save the graphic picture
10. Display the latest process data fully integrated with the graphic display

M. System shall be able to trend and to display, either numerically or graphically: each analog point, each digital point and each calculated point. System shall be able to display graphically simultaneously two trended points within a module function block showing the most recent sixty samples. Each field module shall be capable of storing the more recent 288 samples for every hardware point in the module, with sample intervals as small as one second. Operator

shall be able to select and to display graphically the trends of up to four points simultaneously on a single trend graph.

N. System shall provide runtime information for digital output points and for digital input points, for modules, upon operator command. Maximum runtime limits shall be operator definable and shall be capable of automatically issuing a printed message when the runtime maximum is exceeded. Operator shall be able to reset the runtime accumulator. Runtime hours and start time date shall be retained in non-volatile module memory.

O. System shall allow receipt of alarms and messages while in a functional mode other than energy management, i.e., incoming alarms shall be displayed while the operator is using another mode such as word processing and shall allow the operator to automatically return to word processing after the alarm is received.

1. System shall distinguish between alarms and messages, with alarms having a higher priority.
2. System shall be capable of calling up to three different remote locations to deliver an alarm or message. Operator shall determine if alarms or messages are to be based on temperature limit, status, or off-normal reporting.
3. Text for operator alarm and messages shall be operator definable. System shall be capable of storing minimum 100 messages, each of different length.

P. Field modules shall be capable of calling the central processing unit during off-peak phone rate hours to automatically upload current and accumulated data. System shall be capable of reporting and archiving the following information:

1. Outdoor air temperature history and degree-day history.
2. Electric demand and usage history.
3. All trended points.
4. All alarms and messages.
5. Equipment runtime information.

Q. System shall be capable of reporting following information, for which archiving is not applicable:

1. All points summary.
2. Building operating schedules.
3. Printout of graphic screen.

R. Provide DOS-based text editor program which allows operator to create custom report and logging formats. Custom report generation shall be able to be initiated: manually, based on field occurrence, based on time and any combination. Operator shall be able to have the system:

1. Report the desired point data from the field.
2. Insert the data in custom report format.
3. Store the report on disk.
4. Print out the report on the system printer and/or a remote printer.

S. Provide following application software for optimizing energy consumption while maintaining occupant comfort:

1. Scheduled start/stop (OSS)
2. Optimum start/stop (OSS) and optimum enable/disable (OED)
3. Source temperature optimization (STO)
4. Demand limiting (DL)
5. Day/night setback (DNS)
6. Timed local override (TLO)
7. Direct digital unitary zone control

2.12 ENERGY MANAGEMENT ROUTINES

A. Automation system shall include software for energy management applications. Application routines shall be compatible with, and capable of simultaneous use in, system. Use of any routine shall NOT cause other software to malfunction.

B. Provide the following application routines for energy management:

1. Time of Day
2. Remote Reset
3. Start/Stop Time Optimization
4. Warmup/Cooldown Cycles
5. Timed Override
6. Major system performance reporting including:
    a. Heat Btu/Degree Day
    b. Cool KW per ton for each system
    c. Daily, weekly and monthly totalization of heating and cooling energy

2.13 SEQUENCE OF OPERATION: MAKE-UP AIR UNIT

A. Occupied Cycle:

1. Outdoor air intake damper shall open. Then, supply fan and heat recovery system shall start and run continuously, subject to end switch on the actuators for outdoor air damper.
2. If supply air temperature falls below setpoint, heating coil hot water control valve shall modulate open to bring supply air temperature back to setpoint.
3. If supply air temperature rises above setpoint, heating valve shall close and cooling coil chilled water control valve shall modulate open to bring supply air temperature back to setpoint.

4. Supply air setpoint shall be determined by the following outdoor air reset schedule:

Outdoor Air Temperature	***Supply Air Temperature***
0°F	70°F
75°F and above	70°F

B. Smoke Detection:

1. When smoke is detected by supply or outdoor air smoke detectors (provided under DIVISION 26, ELECTRICAL WORK) , following sequence shall occur:

   a. Supply and exhaust fans shall stop.
   b. Outdoor air damper shall close.
   c. Alarm condition shall be reported at operator terminal in hard copy.

2. Provide tie-in to auxiliary contacts supplied with fire alarm system; refer to DIVISION 26, ELECTRICAL WORK. Contacts shall annunciate at DDC system's input/output devices.

C. Fan shutdown for freeze protection and smoke detection shall be carried out directly through hardwiring to fan starters.

2.14 SEQUENCE OF OPERATION: FAN COIL UNITS - HEATING/COOLING

A. Temperature controls shall consist of independent DDC terminal control units. As part of work of this Section, provide a relay mounted in the fan coil unit enclosure to allow on/off operation of unit. FCU power wiring to relay shall be by DIVISION 26, ELECTRICALW ORK; control wiring shall be provided as part of the work of this Section.

B. A single temperature sensor and unoccupied override control shall be provided for rooms with multiple fan coil units. Temperature sensor shall be provided with local setpoint control.

2.15

2.15 SEQUENCE OF OPERATION: PUMPS

A. DDC system shall allow operating personnel to select which pumps shall run first and which shall run second, to provide even wear on pumps. DDC system shall allow revision of sequencing as often as desirable or according to pre-selected schedule. Switchover of lead pump shall be scheduled based on runtime, with a default switchover runtime of 84 hours.

B. Pump status information shall originate from dry contacts of pump differential pressure switches provided under this Division, or from flow meter.

C. Hot Water Circulator Pumps:

1. DDC system shall start lead pump when outside air temperature falls below 60°F and system is in occupied mode.
2. In unoccupied mode, pumps shall be started and stopped based on DDC zone temperature sensors or upon DDC system input indicating that one of the fan coil units is in the override mode.
3. DDC system shall indicate heating pump failure alarm and shall start lag pump:
   a. If outside air temperature is below 55°F and hot water supply temperature is below 100°F.
   b. If pump status contacts indicate a "no-flow" condition.

Outdoor Temperature	***Supply Water Temperature***
0°F	180°F
60°F	130°F

D. Provide flow meter and matched temperature sensors in high temperature hot water circuit. Provide software to calculate BTUs per month and average BTUs per degree-day for the month.

2.16 SEQUENCE OF OPERATION: PERIMETER RADIATION

A. Day-night room thermostats shall modulate automatic valves in radiation piping, to maintain normal day temperature. During unoccupied periods, thermostats shall maintain lower temperature (night) setpoint.

B. Under morning warm-up cycle, occupied/unoccupied thermostat shall go to occupied setpoint and heating valve shall go to 100% open position, until space temperature is within 3°F of occupied setpoint temperature.

C. In areas served by both VAV air system and perimeter radiation, radiation shall be under control by thermostat which also controls VAV terminal boxes. Radiation valves shall be sequenced so that these two heat sources will work in unison.

2.17 SEQUENCE OF OPERATION: CONVECTORS

A. Dual temperature thermostat shall modulate hot water valve to maintain occupied and unoccupied temperatures.

2.18 SEQUENCE OF OPERATION: UNIT HEATERS

A. Electric single-temperature line voltage thermostat shall operate unit heater fan and heating coil, as needed to maintain space temperature of 60-65°F.

B. In elevator machine room, dual purpose thermostat may be used if thermostat has independent settings that will start exhaust fan upon sensing space temperature over 80°F.

C. Strap-on aquastat shall prevent fan operation if hot water temperature falls below 85°F.

2.19 SEQUENCE OF OPERATION: CABINET UNIT HEATERS

A. Dual temperature thermostat shall modulate hot water valve to maintain desired occupied and unoccupied temperatures.

B. Strap-on thermostat shall prevent fan operation if hot water or steam is NOT available.

2.20 OPERATION: DOMESTIC HOT WATER HEATER

A. Modulate primary high temperature hot water (HTHW) flow to the domestic hot water heat exchanger to maintain setpoint in storage tank. When tank sensor calls for heat, start recirculation pump. When tank sensor is satisfied, stop pump and primary HTHW flow.

B. Totalize monthly BTUs used.

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate with work of DIVISION 26, ELECTRICAL WORK, and work of other Sections of this Division for following:

1. Smoke alarms for air systems, indicated from dry contact relays at local temperature control panels. Relays shall be provided under DIVISION 26, ELECTRICAL WORK.
2. Power to control panels.

B. Provide self-tuning control loops or readjust hardware and software as necessary to compensate for equipment interactions and extremes of outdoor conditions while preserving efficiency and comfort.

3.2 INSTALLATION OF CONTROL WIRING

A. Control troughing and conduit shall be properly supported and anchored; shall be installed in harmony with building lines; and shall NOT interfere with maintenance, service or replacement of other equipment, conduit or piping.

B. Wiring and cables in mechanical equipment spaces or above hung ceilings shall be supported independently from pipes, conduits and ducts of other trades.

C. Wiring, cables and piping shall NOT be dropped over lighting fixtures nor allowed to lay directly on top of ceiling panels or panel support members.

D. Control cable to VFD speed input shall be shielded and shall be installed without excess cable so that electrical noise shall be minimized.

E. Wiring shall be concealed in occupied spaces and protected by conduit where exposed in mechanical rooms, floor-to-floor risers, drops to wall sensor boxes or where subject to damage.

3.3 INSTALLATION OF EQUIPMENT, SENSORS AND VALVES

A. Thermostats shall be mounted 6 feet above finished floors in corridors or stairs; elsewhere, they shall be mounted 66 inches above finished floors. Exact locations shall be coordinated with adjacent light switches and other wall-mounted devices. Space temperature sensor shall be mounted adjacent to thermostat.

B. Control valves shall be installed in true vertical position with operator on top.

3.4 ADJUSTMENT AND CALIBRATION

A. Calibrate, test and adjust controls and control system including pneumatic and electric controls, thermostats, valves, damper motors and relays until system is properly adjusted and ready for use. Management system's hardware and software shall be completely checked, test run and modified as required.

B. Be present for functional tests on systems. Before Engineer is asked to witness functional tests, ensure that:

1. Entire control and management system is complete.
2. Controls are calibrated.
3. Controlled devices and equipment have been physically inspected and checked to ensure that these terminal devices are under proper control and working smoothly over their entire range of operation.

C. Adjustment procedure shall include following steps:

1. Preliminary setup and calibration, as specified and as shown on shop drawings.
2. Physical checkout of all components for completeness and accuracy, simultaneously with system adjustment procedure outlined in DIVISION 23, TESTING, ADJUSTING AND BALANCING, together with any required modifications.
3. Review of system with Engineer.
4. Functional tests for Owner's benefit, instruction and acceptance.
5. Review of problems with Owner, rechecking adjustments and calibration as required. Review, rechecking and calibration shall occur NOT less than 30 days nor more than 60 days after systems have been in full operation.

D. Control and Management systems shall NOT be considered complete nor acceptable until:

1. All conditions of Sequence of Operation have been attained.
2. All temperatures are maintained within specified limits under all operating conditions.
3. All system damper leakage is controlled within specified limits.

E. Where pneumatic-actuated damper operators are required, provide current-to-pneumatic (I/P) transducers mounted within airflow control centers or DDC panels.

F. As part of work of this Section, provide calibration and adjustment of airflow control components and be responsible for setting control setpoints, operating sequences, and alarming systems contained within airflow control centers, to produce following overall system performance. Coordinate with DIVISION 23, TESTING, ADJUSTING AND BALANCING.

1. Constant static pressure control within 5% of duct static setpoint without any hunting or cycling.

3.5 DEMOLITION: IMPACT ON EXISTING SYSTEMS

A. Major changes to existing building spaces have been shown on Contract Drawings; minor changes have NOT been shown. Contractor shall anticipate that there will be numerous minor changes including:

1. Relocation of control piping and control wiring.
2. Relocation of thermostats, due to architectural revisions.
3. Relocation of diffusers and registers.

B. Electrical connections to existing equipment which is to be removed or relocated, including motors, shall be disconnected under DIVISION 26, ELECTRICAL WORK.

C. Electrical system equipment shall be relocated or removed under DIVISION 26, ELECTRICAL WORK.

D. Remove, store and relocate mechanical equipment designated to be relocated and reused.

E. Existing piping, ductwork, controls and mechanical system equipment which are located in areas designated for demolitions and which are not designated to remain shall be removed

under other DIVISIONS (by the General Contractor). Material which is removed and is not designated for reuse shall, at the Owner's option, either:

1. Be delivered to Owner's storage location, OR
2. Become Contractor's property and be removed from the site.

F. Existing piping, ductwork, controls or equipment which are to remain and which are disturbed or damaged during construction shall be replaced with appropriate new materials, equipment or components at no extra cost to the Owner.

END OF SECTION 230940

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SECTION 232300 – REFRIGERANT PIPING

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.
2. Solenoid valves.
3. Hot-gas bypass valves.
4. Filter dryers.
5. Strainers.
6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Shop Drawing Scale: 1/4 inch equals 1 foot.
2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference

between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.8 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.9 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Brazing Filler Metals: AWS A5.8.

D. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Manual operator.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 450 psig.

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.

4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. Equalizer: Internal.
7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
8. End Connections: Socket.
9. Throttling Range: Maximum 5 psig.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.

I. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

J. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

K. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

L. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.

7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

M. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

N. Mufflers:

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

O. Receivers: Comply with ARI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

P. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Atofina Chemicals, Inc.

2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with [brazed] joints.

B. Hot-Gas and Liquid Lines[, and Suction Lines for Heat-Pump Applications]: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with [brazed] [joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with [brazed] joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence of Operations for HVAC Controls" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:

1. Shot blast the interior of piping.
2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

S. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.

4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

D. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

TABLE OF CONTENTS
SECTION 233113 – METAL DUCTS

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
3. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Duct Construction and Design Performance Requirements: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment.

C. Duct Construction Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

D. Coordination Drawings: Plans, drawn to 1/4 scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.

f. Perimeter moldings.

E. Welding certificates.

F. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Linx/Lindab Inc.
b. McGill AirFlow LLC.
c. SEMCO Incorporated.
d. MKT Metal Manufacturing.
e. Eastern Sheet Metal.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

F. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick aluminum; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel, stainless steel, or aluminum.

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

    a. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class. Test must include all duct that will be made inaccessible.
    b. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each

designated pressure class. Test must include all duct that will be made inaccessible.

c. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class. Test must include all duct that will be made inaccessible.

d. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class. Test must include all duct that will be made inaccessible.

e. Smoke Evacuation System Ducts: Exhaust air and pressurization makeup air, for all Pressure Class, totaling no less than 100 percent of total installed duct area for each designated pressure class.

f. Hazardous Exhaust: Exhaust air, including laboratory exhaust, for all Pressure Class, totaling no less than 100 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.8 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel with thicker coating on duct exterior.

B. Supply Ducts: All ducts shall be sealed to meet IECC 2021 duct leakage.

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive 1-inch wg.
b. Minimum SMACNA Seal Class: A.

2. Ducts Connected to Constant-Volume Air-Handling Units:

a. Pressure Class: Positive 2-inch wg.
b. Minimum SMACNA Seal Class: A.

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive 2-inch wg.
b. Minimum SMACNA Seal Class: A.

C. Return Ducts: All ducts shall be sealed to meet IECC 2021 duct leakage.

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive or negative 1-inch wg.
b. Minimum SMACNA Seal Class: A.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative 2-inch wg.
Minimum SMACNA Seal Class: A.

D. Exhaust Ducts: All ducts shall be sealed to meet IECC 2021 duct leakage.

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative 2-inch wg.
b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive or negative 1-inch wg.
b. Minimum SMACNA Seal Class: A.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.

b. Round Elbows, [12 Inches] and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, [14 Inches] and Larger in Diameter: Standing seam or welded.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

TABLE OF CONTENTS
SECTION 233300 – AIR DUCT ACCESSORIES

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Fire dampers.
3. Turning vanes.
4. Duct-mounted access doors.
5. Flexible connectors.
6. Flexible ducts.
7. Duct accessory hardware.

B. Related Sections:

1. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
2. Division 28 Section "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control damper installations.

d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

D. Source quality-control reports.

E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

1.5 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Air Balance Inc.; a division of Mestek, Inc.
   b. Greenheck.
   c. McGill AirFlow LLC.
   d. Nailor Industries Inc.
   e. Ruskin Company.
   f. Vent Products Company, Inc.
   g. Rossi HVAC Hardware.

2. Standard leakage rating, with linkage outside airstream.

3. Suitable for horizontal or vertical applications.

4. Frames:

   a. Hat-shaped, galvanized or stainless-steel channels, 0.064-inch minimum thickness to match ductwork.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized or stainless-steel**,** 0.064 inch thick.

6. Blade Axles: Galvanized steel or stainless steel to match ductwork.

7. Bearings:

    a. Oil-impregnated bronze or molded synthetic or stainless-steel sleeve suited for application.
    b. Dampers in ducts shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Bars and Brackets: Galvanized steel bracket, 3/8” square aluminum bar.

9. Hardware:

    a. Handle:
        1) Self-locking damper/quadrant handle
        2) Twist knob damper handle (flat or 1.5”/2” standoff)

    b. Bracket: Cold Rolled Steel (ASTM A-1008), 18 gauge nominal thickness. Single cut and formed bracket for use with 1.5" or 2.0" insulation wrapping or any other such stand-off applications. Finished with a white Chromate plating process which provides durable corrosion resistance. Auto Planting ASTM B-633 Type II (white) class FE/ZN8 or SC2 Thickness of 0.0003.
    c. Handle and Thumb Trigger: Polyamide 66 (PA66), Flame Retardant, Glass Reinforced, "Zytel". PA66 is the material outlined for use in all Non-Metallic Components as specified in the UL 1995 Standards Code for Heating & Cooling (CSA-C22.2 No. 238 UL 1995) with the required flammability rating of 5VA.
    d. Compression Spring: Stainless Steel Type 302-OD 0.25 wire 0.026 free length of 7/8" (0.875"). Only required with self-locking damper handle.
    e. Retaining Spring: Ext. Self-Lock TX-75ST-ZF Carbon Steel SAE 1074 with Zink Bright Plating. C-Scale Rockwell Hardness 47 to 51. Only required with self-locking damper handle.

B. Standard, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Air Balance Inc.; a division of Mestek, Inc.
    b. Greenheck.
    c. McGill AirFlow LLC.
    d. Nailor Industries Inc.
    e. Ruskin Company.
    f. Vent Products Company, Inc.
    g. Rossi HVAC Hardware.

2. Standard leakage rating, with linkage outside airstream.

3. Suitable for horizontal or vertical applications.

4. Frames: Hat-shaped, 0.10-inch thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Roll-Formed Aluminum Blades: 0.10-inch thick aluminum sheet.
   e. Extruded-Aluminum Blades: 0.050-inch thick extruded aluminum.

6. Blade Axles: Stainless steel.

7. Bearings:

   a. Stainless-steel sleeve.
   b. Dampers in ducts shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Bars and Brackets: Aluminum bracket, 3/8” square aluminum bar.

9. Hardware:

   a. Handle:
      1) Self-locking damper/quadrant handle
      2) Twist knob damper handle (flat or 1.5”/2” standoff)

   b. Bracket: Cold Rolled Steel (ASTM A-1008), 18 gauge nominal thickness. Single cut and formed bracket for use with 1.5" or 2.0" insulation wrapping or any other such stand-off applications. Finished with a white Chromate plating process which provides durable corrosion resistance. Auto Planting ASTM B-633 Type II (white) class FE/ZN8 or SC2 Thickness of 0.0003.
   c. Handle and Thumb Trigger: Polyamide 66 (PA66), Flame Retardant, Glass Reinforced, "Zytel". PA66 is the material outlined for use in all Non-Metallic Components as specified in the UL 1995 Standards Code for Heating & Cooling (CSA-C22.2 No. 238 UL 1995) with the required flammability rating of 5VA.
   d. Compression Spring: Stainless Steel Type 302-OD 0.25 wire 0.026 free length of 7/8" (0.875"). Only required with self-locking damper handle.
   e. Retaining Spring: Ext. Self-Lock TX-75ST-ZF Carbon Steel SAE 1074 with Zink Bright Plating. C-Scale Rockwell Hardness 47 to 51. Only required with self-locking damper handle.

2.3 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. McGill AirFlow LLC.
4. Prefco; Perfect Air Control, Inc.
5. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL. Static rated dampers will not be accepted.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity. If higher duct velocities exist, provide dampers rated for actual flow.

D. Fire Rating: 1-1/2 or 3 hours, as required by Code for the fire rating of the construction penetrated. Refer to Architectural Drawings for ratings.

E. Frame: Curtain type with blades outside airstream Type B or multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: Manufacturer's standard to meet NRTL rating, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

K. Overall damper size is shown on contract drawings. If overall size exceeds the maximum individual damper size, provide multiple dampers to meet the overall size shown. All internal structural supports shall be provided per manufacturers guidelines to maintain the integrity of the damper installation.

2.4 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.

3. SEMCO Incorporated.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

D. Vane Construction: Single wall.

2.5 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Buckley.
2. Greenheck Fan Corporation.
3. McGill AirFlow LLC.
4. Pottorff; a division of PCI Industries, Inc.
5. Ventfabrics, Inc.
6. Ruskin.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; "Duct Access Doors and Panels," and "Access Doors - Round Duct."

1. Door:

a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
d. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

a. Access Doors less than 12 inches square: No hinges and two sash locks.
b. Access Doors up to 18 inches square: Two hinges and two sash locks.
c. Access Doors up to 24 by 48 inches: Three hinges and two compression latches with outside and inside handles.
d. Access Doors larger than 24 by 48 inches: Four hinges and two compression latches with outside and inside handles.

2.6 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flame Gard, Inc.
2. 3M.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon, 0.0428-inch stainless steel.

D. Fasteners: Carbon or stainless steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.7 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches 5-3/4 inches wide attached to 2 strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.8 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Buckley.
2. Flexmaster U.S.A., Inc.
3. McGill AirFlow LLC.

B. Noninsulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil.

1. Pressure Rating: 8-inch wg positive or negative.
2. Maximum Air Velocity: 5000 fpm.
3. Temperature Range: Minus 100 to plus 435 deg F.

C. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

D. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.9 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated on plans.

D. Install volume dampers at points on supply, return, outdoor air and exhaust systems where branches extend from larger ducts. Install volume dampers at takeoffs to diffuser and grilles. Install volume dampers at takeoffs to specialized equipment and terminal units such as chilled beams. Install volume dampers at locations required to properly balance system to achieve specified airflows. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.
3. Install stainless steel volume dampers in stainless steel ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire dampers according to UL listing. Install fire dampers per manufacturers installation instructions. Install fire dampers in locations as required by Code for the fire rating of the construction penetrated. Refer to Architectural drawings for ratings.

1. Less than 3 hour rating: 1-1/2 hr.
2. 3-hour rating or greater: 3 hr.

H. Connect ducts to duct silencers rigidly.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors where duct pressure can be greater than +3.00” SP or can be less than -3.00” SP, or velocity can be greater than 2000 FPM and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot spacing for duct cleaning.
8. Upstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.
12. Grease ducts in accordance with NFPA 96 and applicable codes.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes: Sized suitably to allow inspection, adjusting, maintenance, or service for the component requiring access.

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

L. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

1. Air Systems Below 10,000 CFM: 3-1/2 inch metal-edge connector.
2. Indoor Air Systems: Indoor system flexible connector.

N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

P. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place. Do not use flexible ducts to change directions.

Q. Connect flexible ducts to metal ducts with clamps.

R. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

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SECTION 233713 – DIFFUSERS, REGISTERS, AND GRILLES

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Rectangular and square ceiling diffusers.
2. Fixed face registers and grilles.

B. Related Sections:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Round Ceiling Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Krueger.
b. METALAIRE, Inc.
c. Nailor Industries Inc.
d. Price Industries.
e. Titus.

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Aluminum.
4. Finish: Baked enamel, color selected by Architect.
5. Mounting: Duct connection.

B. Rectangular and Square Ceiling Diffusers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Krueger.
b. METALAIRE, Inc.
c. Nailor Industries Inc.
d. Price Industries.
e. Titus.

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Aluminum.
4. Finish: Baked enamel, color selected by Architect.

2.2 REGISTERS AND GRILLES

A. Fixed Face Register:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Krueger.
b. METALAIRE, Inc.
c. Nailor Industries Inc.
d. Price Industries.

e. Titus.

2. Material: Aluminum.
3. Finish: Baked enamel, color selected by Architect.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
5. Core Construction: Integral.
6. Frame: 1 inch wide.
7. Mounting: Lay in.

B. Fixed Face Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Krueger.
b. Nailor Industries Inc.
c. Price Industries.
d. Titus.

2. Material: Aluminum.
3. Finish: Baked enamel, color selected by Architect.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
5. Core Construction: Integral.
6. Frame: 1 inch wide.
7. Mounting: Lay in.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

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SECTION 237200 – AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

SECTION 237200 - AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Heat wheels.
2. Packaged energy recovery units.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Air-to-air energy recovery equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For air-to-air energy recovery equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For air-to-air energy recovery equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of air-to-air energy recovery equipment.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which equipment or suspension systems will be attached.

B. Seismic Qualification Certificates: For air-to-air energy recovery equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of each type of filter specified.
2. Fan Belts: One set of belts for each belt-driven fan in energy recovery units.
3. Wheel Belts: One set of belts for each heat wheel.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ARI Compliance:

1. Capacity ratings for air-to-air energy recovery equipment shall comply with ARI 1060, "Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment."
2. Capacity ratings for air coils shall comply with ARI 410, "Forced-Circulation Air- Cooling and Air-Heating Coils."

C. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

D. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.

E. UL Compliance:

1. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."

1.9 COORDINATION

A. Coordinate layout and installation of air-to-air energy recovery equipment and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Packaged Energy Recovery Units: Two years.
2. Warranty Period for Fixed-Plate Total Heat Exchangers: 10 years.

3. Warranty Period for Heat Wheel Heat Exchangers: 10 years.

PART 2 - PRODUCTS

2.1 HEAT WHEELS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Advanced Thermal Technologies.
2. Airxchange Inc.
3. Novel-Air.
4. SEMCO Incorporated.
5. Thermotech.

B. Casing:

1. Steel with standard factory-painted finish.
2. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.
3. Casing seals on periphery of rotor and on duct divider and purge section.
4. Support vertical rotors on grease-lubricated ball bearings having extended grease fittings or permanently lubricated bearings. Support horizontal rotors on tapered roller bearing.

C. Rotor: Aluminum segmented wheel strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel desiccant coating.

1. Maximum Solid Size for Media to Pass: 800 micrometer.

D. Rotor: Polymer segmented wheel strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.

1. Maximum Solid Size for Media to Pass: 800 micrometer.

E. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable frequency controller and self-adjusting multilink belt around outside of rotor.

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Controls:

1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.

2. Variable frequency controller, factory mounted and wired, permitting input of field connected 4-20 mA or 1-10-V control signal.
3. Pilot-Light Indicator: Display rotor rotation and speed.
4. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.

G. Extended-Surface, Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
3. Factory-fabricated, dry, extended-surface type.
4. Thickness: 2 inches.
5. Minimum Arrestance: 90, according to ASHRAE 52.1.
6. Minimum Merv: 7, according to ASHRAE 52.2.
7. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.
8. Media-Grid Frame: Nonflammable cardboard.
9. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

2.2 PACKAGED ENERGY RECOVERY UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Advanced Thermal Technologies.
2. Applied Air; Mestek Technology, Inc.
3. Engineered Air.
4. Greenheck Fan Corporation.
5. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
6. RenewAire LLC.
7. SEMCO Incorporated.
8. Trane; American Standard Companies, Inc.
9. Venmar CES Inc.

B. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Housing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum 2-inch- thick thermal insulation, knockouts for electrical and piping connections, exterior drain connection, and lifting lugs.

1. Inlet: Weatherproof hood, with damper for exhaust and supply.

a. Exhaust: Spring-return, two-position, motor-operated damper.
b. Supply: Spring-return, two-position, motor-operated damper.

2. Roof Curb: Refer to Section 077200 "Roof Accessories" for roof curbs and equipment supports.

D. Heat Recovery Device: Heat wheel.

E. Supply and Exhaust Fans: Forward-curved, centrifugal, propeller, backward-inclined, SWSI centrifugal fan with restrained, spring isolators and insulated flexible duct connections.

1. Motor and Drive: Belt driven with adjustable sheaves, motor mounted on adjustable base.
2. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Spring isolators on each fan having 1-inch static deflection.

F. Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
3. Factory-fabricated, viscous-coated, flat-panel type.
4. Thickness: [2 inches].
5. Minimum Merv: [8]according to ASHRAE 52.2.
6. Media: Interlaced glass fibers sprayed with nonflammable adhesiveFrame: Galvanized steel with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

G. Extended-Surface, Disposable Panel Filters:

1. Comply with NFPA 90A.
2. Filter Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lift out from access plenum.
3. Factory-fabricated, dry, extended-surface type.
4. Thickness: 2 inches.
5. Minimum Arrestance: 90, according to ASHRAE 52.1.
6. Minimum Merv: 8, according to ASHRAE 52.2.
7. Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid.
8. Media-Grid Frame: Nonflammable cardboard.
9. Mounting Frames: Welded, galvanized steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

H. Cooling Coils: Rated according to ARI 410 and ASHRAE 33, and bearing the ARI label.

1. Access: Fabricate coil section to allow removal and replacement of coil and to allow in-place access for service and maintenance of coil(s).
2. Casing: Manufacturer's standard material.
3. Tubes: Copper.
4. Tube Headers: Manufacturer's standard material, copper.
5. Fins: Aluminum.
6. Fin and Tube Joint: Mechanical bond.
7. Leak Test: Coils shall be leak tested with air under water.
8. Refrigerant Coils:

    a. Capacity Reduction: Circuit coils for interleaved control.
    b. Suction and Distributor: Seamless copper tube with brazed joints.

I. Cooling-Coil Condensate Drain Pans:

1. Fabricated from stainless-steel sheet and sloped in multiple planes to collect and drain condensate from cooling coils, coil piping connections, coil headers, and return bends.
2. Complying with requirements in ASHRAE 62.1.
3. Drain Connections: At low point of pan with threaded nipple.
4. Units with stacked coils shall have an intermediate drain pan to collect and drain condensate from top coil.

J. Indirect-Fired Gas Furnaces:

1. Description: Factory assembled, piped, and wired; complying with NFPA 54, "National Fuel Gas Code," and ANSI Z21.47, "Gas-Fired Central Furnaces."

    a. AGA Approval: Furnace shall bear label of AGA.

2. Burners: Stainless steel.

    a. Ignition: Electronically controlled electric spark with flame sensor.
    b. High-Altitude Model: For Project at elevations more than 2000 feet above sea level.

3. Heat-Exchanger Drain Pan: Stainless steel.
4. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.
5. Gas Control Valve: Electronic modulating.
6. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff. Control devices and control sequence shall comply with requirements of IRI.
7. Access: Fabricate section to allow removal and replacement of furnace and to allow in-place access for service.

K. Piping and Wiring: Fabricate units with space within housing for piping and electrical conduits. Wire motors and controls so only external connections are required during installation.

1. Indoor Enclosure: NEMA 250, Type 12 enclosure contains relays, starters, and terminal strip.
2. Outdoor Enclosure: NEMA 250, Type 3R enclosure contains relays, starters, and terminal strip.
3. Include nonfused disconnect switches.

L. Accessories:

1. Roof Curb: Galvanized steel with gasketing, and factory-installed wood nailer; complying with NRCA standards; minimum height of 14 inches, 24 inches.
2. Intake weather hood with 2-inch- thick filters.
3. Exhaust weather hood with birdscreen.
4. Low-Leakage, Isolation Dampers: Double-skin, airfoil-blade, extruded-aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals, in opposed-blade arrangement with cadmium-plated steel operating rods rotating in stainless-steel sleeve, sintered bronze or nylon bearings mounted in a single extruded-aluminum frame, with operating rods connected with a common linkage, and electric damper operator factory wired. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.
5. Duct flanges.
6. Hinged access doors with quarter-turn latches.
7. Drain pans for condensate removal complying with ASHRAE 62.1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install heat wheels so supply and exhaust airstreams flow in opposite directions and rotation is away from exhaust side to purge section to supply side.

1. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.
2. Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.
3. Access doors and panels are specified in Section 233300 "Air Duct Accessories."

B. Install gas-fired furnaces according to NFPA 54, "National Fuel Gas Code."

C. Install floor-mounted units on 4-inch- high concrete base designed to withstand, without damage to equipment, seismic force required by code.

D. Roof Curb: Install on roof structure or concrete base, level and secure, according to ARI Guideline B. Install air-to-air energy recovery equipment on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure air-to-air energy recovery equipment to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

E. Install units with clearances for service and maintenance.

F. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

G. Pipe drains from drain pans to nearest floor drain; use ASTM B 88, Type L, drawn-temper copper water tubing with soldered joints, same size as condensate drain connection.

1. Requirements for Low-Emitting Materials:

a. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Requirements for Low-Emitting Materials: Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Connect piping to units mounted on vibration isolators with flexible connectors.

D. Connect cooling condensate drain pans with air seal trap at connection to drain pan and install cleanouts at changes in pipe direction.

E. Chilled and Hot Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping."

G. Gas Piping: Comply with requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service. Make connection with AGA-approved flexible connectors.

H. Comply with requirements for ductwork specified in Section 233113 "Metal Ducts."

I. Install electrical devices furnished with units but not factory mounted.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Adjust seals and purge.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Set initial temperature and humidity set points.
5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

END OF SECTION 237200

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SECTION 237413 – OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

SECTION 237413 - OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:

1. Direct-expansion cooling.
2. Heat-pump refrigeration components.
3. Hot-gas reheat.
4. Gas furnace.
5. Economizer outdoor- and return-air damper section.
6. Integral, space temperature controls.
7. Roof curbs.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

B. ECM: Electrically commutated motor.

C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

H. VVT: Variable-air volume and temperature.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design RTU supports to comply with wind and seismic performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Wind-Restraint Performance:

1. Basic Wind Speed: 140mph
2. Building Classification Category: [**III**]
3. Minimum 10 lb/sq. ft multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

C. Seismic Performance: RTUs shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Refer to Section 230548 “Vibration and Seismic Controls for HVAC Piping and Equipment” for additional requirements.

1.5 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. LEED Submittals:

1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

D. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Wind- and Seismic-Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which RTUs will be attached.
2. Roof openings.
3. Roof curbs and flashing.

B. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Manufacturer Seismic Qualification Certification: Submit certification that RTUs, accessories, and components will withstand seismic forces defined in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.

E. Warranty: Special warranty specified in this Section.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-driven fan.
2. Filters: One set of filters for each unit.

1.9 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than 5 years from date of Substantial Completion.
2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 5 years from date of Substantial Completion.
3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than 3 years from date of Substantial Completion.
4. Warranty Period for Control Boards: Manufacturer's standard, but not less than 3 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Carrier Corporation.
2. McQuay International.
3. Trane; American Standard Companies, Inc.
4. YORK International Corporation.

2.2 CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

1. Exterior Casing Thickness: .052 inch thick.

C. Inner Casing Fabrication Requirements:

1. Inside Casing: Galvanized steel, 0.034 inch.

D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.
2. Thickness: 1 inch.

3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
4. Liner Adhesive: Comply with ASTM C 916, Type I.

E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Threaded nipple both sides of drain pan.

F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.3 FANS

A. Direct-Driven Supply-Air Fans: Double width, or backward inclined, centrifugal; with permanently lubricated, ECM motor if available for the required size, motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

B. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

C. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

D. Relief-Air Fan: Forward curved or backward inclined, shaft mounted on permanently lubricated motor.

E. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment" when fan-mounted frame and RTU-mounted frame are anchored to building structure.

F. Fan Motor: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.4 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum fin and seamless copper tube in steel type vertical distributor
2. Coil Split: Interlaced.

3. Condensate Drain Pan: Formed with pitch and drain connections complying with ASHRAE 62.1.

B. Hot-Gas Reheat Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.

2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: Per Schedule drawing.

B. Compressor: Hermetic or semi-hermetic, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

C. Refrigeration Specialties:

1. Refrigerant: R-407C, R-410A or other HFC.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.
9. Low-ambient kit high-pressure sensor.
10. Hot-gas reheat solenoid valve with a replaceable magnetic coil.
11. Hot-gas bypass solenoid valve with a replaceable magnetic coil.

2.6 AIR FILTRATION

1. Pleated: Minimum 90 percent arrestance, and MERV 7 value.

2.7 GAS FURNACE

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.

1. CSA Approval: Designed and certified by and bearing label of CSA.

B. Burners: Stainless steel.

1. Fuel: Natural gas.
2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
3. High-Altitude Model: For Project elevations more than 2000 feet above sea level.

C. Heat-Exchanger and Drain Pan: Stainless steel.

D. Venting: Gravity vented with vertical extension.

E. Safety Controls:

1. Gas Control Valve: Modulating.
2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.8 DAMPERS

A. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.
2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.9 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.10 CONTROLS

A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC."

B. Interface Requirements for HVAC Instrumentation and Control System:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
3. Provide BACnet compatible interface for central HVAC control workstation for the following:

a. Adjusting set points.
b. Monitoring supply fan start, stop, and operation.
c. Inquiring data to include outdoor-air damper position**,** supply- and room-air temperature and humidity.
d. Monitoring occupied and unoccupied operations.
e. Monitoring constant and variable motor loads.
f. Monitoring variable-frequency drive operation.

g. Monitoring cooling load.
h. Monitoring economizer cycles.
i. Monitoring air-distribution static pressure and ventilation air volume.

2.11 ACCESSORIES

A. Electric heater with integral thermostat maintains minimum 50 deg F temperature in gas burner compartment.

B. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open**.**

C. Low-ambient kit using [variable-speed] condenser fans for operation down to 35 deg F .

D. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

E. Coil guards of painted, galvanized-steel wire.

F. Hail guards of galvanized steel, painted to match casing.

G. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

2.12 ROOF CURBS

A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

a. Materials: ASTM C 1071, Type I or II.
b. Thickness: 1 inch.

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

a. Liner Adhesive: Comply with ASTM C 916, Type I.
b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
d. Liner Adhesive: Comply with ASTM C 916, Type I.

B. Curb Height: 24 inches.

C. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment" for wind-load requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger than supported equipment and minimum 6 inches above finished ground elevation.
2. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.
4. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
5. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete" or Section 033053 "Miscellaneous Cast-in-Place Concrete."

B. Equipment Mounting: Install RTUs on concrete base using restrained spring isolators. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete" or Section 033053 "Miscellaneous Cast-in-Place Concrete."

1. Minimum Deflection: To give 90% isolation efficiency.

C. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

D. Install wind and seismic restraints according to manufacturer's written instructions. Wind and seismically restrained vibration isolation roof-curb rails are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

3.3 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

B. Install piping adjacent to RTUs to allow service and maintenance.

1. Gas Piping: Comply with applicable requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.
5. Install normal-weight, 3000-psi, compressive strength (28-day) concrete mix inside roof curb, 4 inches thick. Concrete, formwork, and reinforcement are specified with concrete.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.

B. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Inspect operation of barometric relief dampers.
14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.

    a. Start refrigeration system.
    b. Do not operate below recommended low-ambient temperature.
    c. Complete startup sheets and attach copy with Contractor's startup report.

18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.

a. Measure gas pressure on manifold.
b. Inspect operation of power vents.
c. Measure combustion-air temperature at inlet to combustion chamber.
d. Measure flue-gas temperature at furnace discharge.
e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

21. Calibrate thermostats.
22. Adjust and inspect high-temperature limits.
23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:

    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outdoor-air intake volume.

27. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:

    a. High-temperature limit on gas-fired heat exchanger.
    b. Low-temperature safety operation.
    c. Filter high-pressure differential alarm.
    d. Economizer to minimum outdoor-air changeover.
    e. Relief-air fan operation.
    f. Smoke and firestat alarms.

29. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 237413

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SECTION 238125 – VARIABLE REFRIGERANT VOLUME (VRV) AIR CONDITIONING SYSTEM

SECTION 238125 – VARIABLE REFRIGERANT VOLUME (VRV) AIR CONDITIONING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes variable refrigerant split-system air-conditioning and heat pump and heat recovery systems. Either system consists of condensing units (also called outdoor units) containing compressors and coils with fans, and indoor units containing coils and fans. The outdoor and indoor units are connected by suitable piping and control devices. In the heat pump systems, all indoor units connected to one outdoor unit are in either heating or cooling mode. In the heat recovery system, some of the indoor units connected to one outdoor unit may be heating while others connected to the same outdoor unit are cooling. Indoor units are designed for exposed or concealed mounting, and may be connected to ducts.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Provide a spreadsheet listing the indoor units that are served by each outdoor unit. For each indoor unit, list the actual (not nominal) cooling and heating outputs taking design conditions, piping losses, etc into account. Group the rooms by zones and list the de-rated cooling and heating outputs for each zone.

C. Shop Drawings: Diagram power, signal, and control wiring.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For all equipment and systems to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

1.4 1.4 QUALITY ASSURANCE

A. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

B. All wiring shall be in accordance with the National Electrical Code (NEC).

C. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.

D. Outdoor equipment for regions with wind-borne debris shall be designed in accordance with ASCE 7-2002 and installed to resist the wind pressures on the equipment and supports.

E. The VRV system shall be installed by a company certified as qualified by the equipment manufacturer.

F. The VRV system shall be commissioned by the manufacturer or certified manufacturer's agent.

1.5 COORDINATION

A. Coordinate size and location of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."

B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 7 Section "Roof Accessories."

1.6 WARRANTY

A. Warranty:
   1. The units shall be covered by an extended manufacturer's limited warranty for a period of five (5) years from date of installation.
   2. In addition, the compressor shall have a manufacturer's limited warranty for a period of six (6) years from date of installation.
   3. 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.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set of filters for each unit.
   2. Fan Belts: One set of belts for each unit.

PART 2 - 2PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products indicated on the Drawings or comparable product by one of the following:
   1. Mitsubishi / Trane
   2. Daikin
   3. LG

2.2 CONDENSING UNIT (OUTDOOR UNIT)

A. General: The condensing unit shall be suitable for operation with the selected indoor units. The models for heat recovery and heat pumps shall have the required features and controls.
   1. The condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator. Liquid and suction lines must be individually insulated between the condensing and indoor units.
   2. The condensing unit can be wired and piped with access from the left, right, rear or bottom.
   3. Each condensing unit shall be able to support the connection of up to 41 indoor units dependant on the model of the condensing unit.
   4. The units will have low noise levels. The condensing unit shall be capable of operating automatically at further reduced noise during the night.
   5. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
   6. The condensing unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
   7. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
   8. Oil recovery cycle shall be automatic occurring at pre-determined intervals. Each system shall maintain continuous heating during oil return operation.
   9. The condensing unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls or an auxiliary heat source.
   10. The outdoor unit will be able to operate in cooling only mode down to 21 F and up to 110 F outdoor temperature.
   11. The system shall continue to provide heat to the indoor units while in the defrost mode.

B. Unit Cabinet:
   1. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

C. Fan:
   1. The condensing unit shall consist of one or more propeller type, direct-drive 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
   2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure shall be available to accommodate field-applied duct for indoor mounting of condensing units.
   3. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
   4. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
   5. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Night time sound pressure at 3 feet distance from the unit should not exceed 45 dB(A).

D. Condenser Coil:
   1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
   2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
   3. The heat exchanger on the condensing units shall be manufactured from seamless copper tube mechanically bonded on to aluminum fins.
   4. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film.
   5. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

E. Compressor:
   1. The inverter scroll compressors shall be variable speed (PVM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit.
   2. The capacity control range shall be as low as 6% to 100%.
   3. Each non-inverter compressor shall also be of the hermetically sealed scroll type.
   4. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
   5. Oil separators shall be standard with the equipment together with an intelligent oil management system.
   6. The compressor shall be spring mounted to avoid the transmission of vibration.
   7. Units sized 6-9 tons shall contain a minimum of 2 compressors; 12-20 ton units shall contain a minimum of 4 compressors. In the event of compressor failure the remaining compressors shall continue to operate and provide heating or cooling as required at a

proportionally reduced capacity. The microprocessor and associated controls shall be designed to specifically address this condition.

8. In units with two compressors, at least one of them shall be variable speed. In units with four compressors, at least two will be variable speed.
9. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost, or at fixed intervals.

F. Electrical:
1. The power supply to the condensing unit shall be as listed in the schedule drawing.
2. The control circuit between the indoor and condensing unit shall be low voltage DC, stranded 2-conductor cable.

2.3 INDOOR UNITS

A. General: Indoor units shall be of the type and configuration listed in the schedule drawings. These may include floor-mounted, wall-mounted. furred-in, cassette type, etc.

B. Performance: Each unit's performance shall be as listed in the schedule drawing.

C. Indoor Unit Features:
1. The unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, fused time delay, and test run switch.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air or nitrogen prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. Return air shall be through an antibacterial filter.
5. The indoor units shall be equipped with a condensate pan with antibacterial treatment and condensate pump. The condensate pump provides up to 33-1/2" of lift and has a built in safety shutoff and alarm.
6. The indoor units shall be equipped with a return air thermistor.

D. Unit Cabinet:
1. Outside air intake shall be possible. Suitable opening shall be provided for connecting outside air.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
3. Optional high efficiency MERV 8 and 13 air filters shall be available for each model unit.

E. Fan:
1. The fan shall be direct-drive with statically and dynamically balanced impeller with three fan speeds available.

2. The airflow rate shall be available in three settings.
3. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings to allow operation with MERV 8 and 13 filter options.
4. The fan motor shall be thermally protected.

F. Filter:
1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin and antibacterial treatment.
2. Optional high efficiency disposable MERV 8 and 13 filters shall be available.

G. Coil:
1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The refrigerant connections shall be flare connections and the condensate will be 1 -1/4 inch outside diameter PVC.
3. A condensate pan with antibacterial treatment shall be located under the coil.
4. A condensate pump shall be located below the coil in the condensate pan with a built in safety alarm.
5. A thermistor will be located on the liquid and gas line.

H. Electrical:
1. Power supply shall be as listed in the schedule drawing. All units shall be capable of satisfactory operation within +/-10% of nominal supply voltage
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

I. Control:
1. The unit shall have controls provided by the manufacturer to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with a BMS system via BACnet gateway.

2.4 HEAT RECOVERY SELECTOR UNITS FOR SIMULTANEOUS HEATING & COOLING

A. General:
1. Heat recovery selector units shall be designed for use with VRF/VRV equipment of the same manufacturer.
2. Heat recovery selector units shall have factory installed control boards that interface to the VRV equipment controls system and shall perform all functions to effectively and efficiently control the simultaneous heating and cooling VRV system.
3. Heat recovery selector units shall be completely factory assembled, internally piped and wired.
4. Heat recovery selector units shall be run tested at the factory.
5. Shall be designed for indoor installation.
6. Shall use R410A refrigerant or other HFC refrigerant.

7. All refrigerant lines from the outdoor unit to the indoor units shall be field insulated.
8. Each heat recovery unit shall allow several indoor units to be connected to it.
9. The following piping shall be allowed.
    a. Indoor units up to 130 equivalent feet of piping length from the respective heat recovery unit.
    b. Indoor units up to 295 equivalent feet of piping length from the first branch
    c. Indoor units at least 16 feet above or below the heat recovery unit
    d. Elevation difference between the highest and lowest elevation indoor unit at least 16 feet.

B. Heat Recovery Unit Construction:
1. The heat recovery unit shall have several ports which can individually accommodate one indoor unit.
2. The heat recovery unit housing shall be galvanized steel.
3. Each heat recovery unit shall contain piping, valves and controls to divert refrigerant for optimum efficiency.
4. Heat recovery units shall be internally insulated.

C. Refrigerant System:
1. R410A refrigerant (or another HFC) shall be used for all VRF equipment and components including indoor units, outdoor units, refrigerant piping, valves, Y-branches, heat recovery units, etc. as applicable.

D. Refrigerant valves:
1. Each port shall be circuited with automatic valves to control refrigerant flow path.
2. Isolation valves shall be field supplied and installed for ease of service to the heat recovery unit without evacuating the entire system refrigerant charge.

E. Electrical:
1. All units shall be capable of satisfactory operation within +/-10% of nominal supply voltage.
2. The heat recovery unit shall be controlled by integral microprocessors from the main controller.
3. The control circuit between the indoor units, heat recovery box and the outdoor unit shall be low voltage DC completed using a 2-conductor cable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electric installations for indoor and outdoor units to verify actual locations of piping connections and electrical conduits before installation.

3.2 Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Outdoor Equipment Mounting: Install units using restrained spring isolators. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
   1. Minimum Deflection: As needed to give 90% isolation efficiency.

B. Indoor Equipment Mounting: Install indoor units with continuous-thread hanger rods and spring hangers of size required to support weight of units.
   1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
   2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

C. Install wall-mounting thermostats, humidistats, and switch controls in electrical outlet boxes at heights to match lighting controls or as required in Section 230900 "Instrumentation and Control for HVAC."

3.4 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
   1. Install refrigerant piping connecting indoor and outdoor units and heat recovery selector units according to manufacturer’s instructions.
   2. Connect condensate drain pan to indirect waste connection with condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Duct installation requirements are specified in other Sections. Drawings indicate general arrangement of ducts. Specific connection requirements are as follows:
   1. Connect supply and return ducts to VRV units with flexible duct connectors specified in Section 233300 "Air Duct Accessories."

C. Install electrical devices furnished by manufacturer but not specified to be factory mounted.

D. Install piping adjacent to machine to allow service and maintenance.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following field tests and inspections:
   1. After installing the units and after electrical circuitry has been energized, test units for compliance with requirements.
   2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Equipment will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
   1. Inspect for visible damage to unit casing.
   2. Inspect for visible damage to compressor, coils, and fans.
   3. Inspect internal insulation.
   4. Verify that labels are clearly visible.
   5. Verify that clearances have been provided for servicing.
   6. Verify that controls are connected and operable.
   7. Verify that filters are installed.
   8. Adjust vibration isolators.
   9. Verify bearing lubrication on fan.
   10. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
   11. Adjust fan belts to proper alignment and tension.
   12. Start unit according to manufacturer's written instructions.
   13. Complete startup sheets and attach copy with Contractor's startup report.
   14. Inspect and record performance of interlocks and protective devices; verify sequences.
   15. Operate unit for an initial period as recommended or required by manufacturer.
   16. Verify thermostat and humidistat calibration.
   17. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
   18. Inspect controls for correct sequencing of heating, cooling, refrigeration, and normal and emergency shutdown.

3.7 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.8 CLEANING

A. Replace filters used during construction prior to air balance or Substantial Completion.

B. After completing installation of exposed, factory-finished, outdoor units, inspect exposed finishes and repair damaged finishes.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the VRV air conditioning system.

END OF SECTION 238125

MECHANICAL CONTROLS LEGEND

SYMBOL	DESCRIPTION
AI	CONTROL POINT, ANALOG INPUT
AO	CONTROL POINT, ANALOG OUTPUT
DI	CONTROL POINT, DIGITAL INPUT
DO	CONTROL POINT, DIGITAL OUTPUT
A	AIRCUITY SENSOR
BLS	POSITIONING BLADE SWITCH
IS	ELECTRICAL CURRENT SWITCH
CO	CARBON MONOXIDE SENSOR
CO_2	CARBON DIOXIDE SENSOR
DH	DUCT HEAT DETECTOR
DP	DIFFERENTIAL PRESSURE SWITCH
D	DUCT SMOKE DETECTOR
ES	END SWITCH
F	FLOW METER
FS	FLOW SWITCH
H	HUMIDISTAT
HT	HIGH TEMPERATURE THERMOSTAT
K	KEY OPERATED SWITCH
L	LEVEL SENSOR
LT	LOW TEMPERATURE THERMOSTAT (FREEZE)
M	MOTOR OR ACTUATOR
MS	MOISTURE SENSOR
O	OXYGEN SENSOR
OR	OVERRIDE BUTTON
OCC / E	OCCUPANCY SENSOR
P	PRESSURE SENSOR
PB	PUSH BUTTON
PPB	PURGE PUSH BUTTON
PS	PRESSURE SWITCH
RH	RELATIVE HUMIDITY SENSOR
RS	RADIANT SLAB / SNOW MELT SENSOR
S	WALL MOUNTED ROOM SENSOR (TEMP, RH, CO_2, CO, ETC.) REFER TO ROOM BY ROOM CONTROL MATRIX FOR SPECIFIC ROOM SENSOR TYPE(S).
T	TEMPERATURE SENSOR
TS	TIMER SWITCH
WCS	WINDOW CONTACT SWITCH
	AIRFLOW CONTROLLER
	AUTOMATIC CONTROL VALVE, 2-WAY
	AUTOMATIC CONTROL VALVE, 3-WAY
	AUTOMATIC CONTROL VALVE, 6-WAY
	BUTTERFLY VALVE, MOTORIZED
	CHILLED BEAM, ACTIVE
	CHILLED BEAM, PASSIVE
	COIL, COOLING
	COIL, HEATING
	COIL, REHEAT
	DAMPER, GRAVITY
	DAMPER, MOTORIZED OPPOSED BLADE
	DAMPER, MOTORIZED PARALLEL BLADE
	FAN; SUPPLY, RETURN OR EXHAUST
	FILTER
	HUMIDIFIER
	LAB AIR CONTROL VALVE
	LAB AIR CONTROL VALVE, VENTURI
	PUMP
	RADIANT CEILING PANEL
	RADIANT FLOOR
	STARTER / DISCONNECT
	VARIABLE FREQUENCY DRIVE
	VARIABLE AIR VOLUME BOX
	VARIABLE AIR VOLUME BOX w/ INTEGRAL REHEAT COIL
	VISUAL INDICATOR

MECHANICAL PIPING SYSTEMS LEGEND

SYMBOL	DESCRIPTION
	AUTOMATIC CONTROL VALVE
	BALANCE VALVE
	BALL VALVE
	BUTTERFLY VALVE
	CHECK VALVE
	ISOLATION VALVE
	MULTI-PURPOSE VALVE (BALANCE, CHECK, SHUT-OFF)
	OUTSIDE SCREW & YOKE GATE VALVE (OS&Y)
	PRESSURE REDUCING VALVE
	PRESSURE RELIEF VALVE
	3-WAY CONTROL VALVE
6	6-WAY CONTROL VALVE
	ELBOW, TURNED DOWN
	ELBOW, TURNED UP
	BRANCH OFF TOP OF MAIN
	BRANCH OFF BOTTOM OF MAIN
	PIPING TO BE REMOVED
C	CONDENSATE DRAIN LINE
CHGR	CHILLED GLYCOL RETURN
CHGS	CHILLED GLYCOL SUPPLY
CHWR	CHILLED WATER RETURN
CHWS	CHILLED WATER SUPPLY
CPD	CONDENSATE PUMP DISCHARGE
CGR	CONDENSER GLYCOL RETURN
CGS	CONDENSER GLYCOL SUPPLY
CWR	CONDENSER WATER RETURN
CWS	CONDENSER WATER SUPPLY
DTWR	DUAL TEMPERATURE WATER RETURN
DTWS	DUAL TEMPERATURE WATER SUPPLY
FOR	FUEL OIL RETURN
FOS	FUEL OIL SUPPLY
HGR	HOT GLYCOL RETURN
HGS	HOT GLYCOL SUPPLY
HPC	HIGH PRESSURE CONDENSATE
HPS	HIGH PRESSURE STEAM
HRGR	HEAT RECOVERY GLYCOL RETURN
HRGS	HEAT RECOVERY GLYCOL SUPPLY
HRWR	HEAT RECOVERY WATER RETURN
HRWS	HEAT RECOVERY WATER SUPPLY
HWR	HOT WATER RETURN
HWS	HOT WATER SUPPLY
LPC	LOW PRESSURE CONDENSATE
LPS	LOW PRESSURE STEAM
MCHWR	MEDIUM TEMPERATURE CHILLED WATER RETURN
MCHWS	MEDIUM TEMPERATURE CHILLED WATER SUPPLY
MPC	MEDIUM PRESSURE CONDENSATE
MPS	MEDIUM PRESSURE STEAM
PHHWR	PRE-HEAT HOT WATER RETURN
PHHWS	PRE-HEAT HOT WATER SUPPLY
RG	REFRIGERANT HOT GAS
RL	REFRIGERANT LIQUID
RS	REFRIGERANT SUCTION
	PIPE GUIDE
	PIPE ANCHOR
	AIR VENT (MANUAL OR AUTOMATIC)
	FINNED TUBE RADIATION
	FLOAT & THERMOSTATIC TRAP ASSEMBLY
	INVERTED BUCKET TRAP ASSEMBLY
	PRESSURE GAUGE
	PUMP
	STRAINER
	THERMOMETER
	UNION
	DEMOLITION WORK: POINT OF REMOVAL NEW WORK: POINT OF ATTACHMENT

MECHANICAL AIR SYSTEMS LEGEND

SYMBOL	DESCRIPTION
	SUPPLY DUCT UP
	SUPPLY DUCT DOWN
	RETURN DUCT UP
	RETURN DUCT DOWN
	EXHAUST DUCT UP
	EXHAUST DUCT DOWN
	EXISTING DUCT (SINGLE LINE)
	EXISTING DUCT (DOUBLE LINE)
	NEW DUCT (SINGLE LINE)
	NEW DUCT (DOUBLE LINE)
	ACOUSTICALLY LINED DUCT (SINGLE LINE)
	ACOUSTICALLY LINED DUCT (DOUBLE LINE)
	FIRE WRAPPED DUCT (DOUBLE LINE)
	DUCT TO BE REMOVED (SINGLE LINE)
	DUCT TO BE REMOVED (DOUBLE LINE)
	FLUSH CAP, SINGLE LINE
	SUPPLY DIFFUSER
	RETURN GRILLE
	EXHAUST GRILLE
	SUPPLY AIR FLOW
	RETURN/EXHAUST AIR FLOW
LD	LOUVER DOOR (SIZE AS NOTED)
UD	UNDER CUT DOOR
	REHEAT COIL
	VAV BOX
	VAV BOX WITH INTEGRAL SOUND ATTENUATOR
AFC	AIRFLOW CONTROLLER
AFCD	AIRFLOW CONTROLLER WITH INTEGRAL SHUTOFF DAMPER
	LABORATORY AIRFLOW CONTROL VALVE
	SOUND ATTENUATOR
ACD	AUTOMATIC CONTROL DAMPER
FD	FIRE DAMPER
GD	GRAVITY DAMPER
VD	VOLUME DAMPER
FSD	FIRE SMOKE DAMPER
SD	SMOKE DAMPER
	OPPOSED BLADE DAMPER
	PARALLEL BLADE DAMPER
	HUMIDIFIER
	DEMOLITION WORK: POINT OF REMOVAL NEW WORK: POINT OF ATTACHMENT

MECHANICAL ABBREVIATIONS LEGEND

AC	AIR CURTAIN
ACCU	AIR COOLED CONDENSING UNIT
ACU	AIR CONDITIONING UNIT
ACV	AIRFLOW CONTROL VALVE
AFF	ABOVE FINISHED FLOOR
AHU	AIR HANDLING UNIT
AS	AIR SEPARATOR
B	BOILER
BMS	BUILDING MANAGEMENT SYSTEM
CA	COMBUSTION AIR
CFM	CUBIC FEET PER MINUTE
CH	CHILLER
CP	CONDENSATE PUMP
CU	CONDENSING UNIT
CUH	CABINET UNIT HEATER
DN	DOWN
DOAS	DEDICATED OUTDOOR AIR SYSTEM
DX	DIRECT EXPANSION
EA	EXHAUST AIR
EF	EXHAUST FAN
EMH	ELECTRICAL MANHOLE
ERV	ENERGY RECOVERY VENTILATOR
ET	EXPANSION TANK
FCU	FAN COIL UNIT
FTR	FINNED TUBE RADIATION
GEN	GENERATOR
GEX	GENERAL EXHAUST
GPM	GALLONS PER MINUTE
HRU	HEAT RECOVERY UNIT
HUM	HUMIDIFIER
HWC	HOT WATER COIL
HX	HEAT EXCHANGER
LEA	LABORATORY EXHAUST AIR
LSA	LABORATORY SUPPLY AIR
M	MANIFOLD FOR RADIANT FLOOR
NLEA	NON-LAB EXHAUST AIR
NLSA	NON-LAB SUPPLY AIR
OA	OUTSIDE AIR
P	PUMP
RA	RETURN AIR
RCP	RADIANT CEILING PANEL
RHC	REHEAT COIL
SA	SUPPLY AIR
SATT	SOUND ATTENUATOR
SF	SUPPLY FAN
SMH	STEAM MANHOLE
TYP	TYPICAL
UH	UNIT HEATER
VAV	VARIABLE AIR VOLUME
VFD	VARIABLE FREQUENCY DRIVE
VRF	VARIABLE REFRIGERANT FLOW

MECHANICAL GENERAL NOTES

A. ALL MATERIALS, METHODS AND EQUIPMENT INSTALLED UNDER THIS CONTRACT SHALL BE IN COMPLIANCE WITH ALL APPLICABLE CODES AND REGULATIONS.

B. COORDINATE EXACT LOCATIONS, MOUNTING HEIGHTS, AND FINISHES WITH THE ARCHITECTURAL DRAWINGS.

C. ALL EQUIPMENT SHALL BE INSTALLED IN ACCESSIBLE LOCATIONS. IN THE INSTANCE WHERE EQUIPMENT MUST BE INSTALLED BEHIND A WALL OR ABOVE AN INACCESSIBLE CEILING, AN APPROPRIATELY SIZED ACCESS DOOR SHALL BE PROVIDED. REFER TO ARCHITECTURAL PLANS FOR ACCESS DOOR LOCATIONS IN WALLS, CEILINGS AND FLOORS.

D. IN THE EVENT OF A CONFLICT BETWEEN DOCUMENTS, ARCHITECT SHALL BE NOTIFIED AND THE LARGER QUANTITY AND/OR MORE EXPENSIVE ITEMS SHALL BE CARRIED AS PART OF THE BID.

E. THERMOSTAT AND SWITCH LOCATIONS SHALL BE GENERALLY AS SHOWN. ACTUAL LOCATIONS SHALL BE COORDINATED WITH ARCHITECTURAL ELEVATIONS.

F. ALL FLOOR MOUNTED AIR HANDLING UNITS SHALL BE INSTALLED ON A 6" CONCRETE HOUSEKEEPING PAD AND ALL OTHER FLOOR MOUNTED EQUIPMENT SHALL BE INSTALLED ON A 4" CONCRETE HOUSEKEEPING PAD, UNLESS OTHERWISE NOTED.

G. PROVIDE SEISMIC RESTRAINTS ON ALL EQUIPMENT AND PIPING IN COMPLIANCE WITH PROJECT SPECIFICATIONS AND APPLICABLE CODES.

H. THESE PLANS ARE DIAGRAMMATIC IN NATURE. EVERY ELBOW, FITTING, ETC. ARE NOT SHOWN. PROVIDE SUCH COMPONENTS AS REQUIRED FOR COMPLETE INSTALLATION, PROPERLY COORDINATED WITH ALL TRADES.

I. THE HVAC SYSTEMS FOR THIS BUILDING HAVE BEEN DESIGNED AND MODELED FOR LOW TRANSPORT ENERGY (LOW VELOCITY AND LOW PRESSURE DROP). WHEN OFFSETTING THE DUCTWORK AND PIPING IS REQUIRED, THE CONTRACTOR SHALL MAKE EVERY EFFORT TO MINIMIZE THE NUMBER OF FITTINGS AND TRANSITIONS AND TO PROVIDE FITTING TYPES WITH THE LEAST POSSIBLE PRESSURE DROP.

J. ANY DUCTWORK AND PIPING NOT SERVING STAIRWELLS, SHAFTS, ELEVATOR MACHINE ROOMS OR EMERGENCY ELECTRICAL ROOMS SHALL NOT PENETRATE THOSE WALLS.

K. DUCTWORK AND/OR PIPING SHALL NOT BE INSTALLED OVER ELECTRICAL PANELS.

L. COORDINATE NEW DUCTWORK AND PIPING WITH OTHER TRADES. CONTRACTOR SHALL FIELD VERIFY AVAILABLE CEILING CLEARANCE PRIOR TO BID.

M. PROVIDE VOLUME DAMPERS IN ALL SUPPLY, RETURN, OUTSIDE AIR AND EXHAUST BRANCH DUCTS NEAR THE MAIN DUCT TAKE-OFF AS REQUIRED TO PROPERLY BALANCE THE ENTIRE AIR SYSTEM. PROVIDE REMOTELY OPERATED (CABLE) DAMPERS WHEN DAMPERS ARE INACCESSIBLE. COORDINATE WITH ARCHITECTURAL REFLECTED CEILING PLANS.

N. DUCT SIZING SHOWN INDICATES CLEAR INSIDE DIMENSIONS OF DUCT AND INSULATION.

O. PROVIDE NEW DUCTWORK, DIFFUSERS AND GRILLES WHERE SHOWN, SEE SPECIFICATIONS. COORDINATE NEW DIFFUSER LOCATIONS WITH ARCHITECT'S REFLECTED CEILING PLAN.

P. ALL FLEXIBLE DUCT SHALL BE A MAXIMUM OF 3 FEET LONG WITH NO BENDS GREATER THAN 45 DEGREES.

Q. SUPPORT ALL PIPING FROM STRUCTURE ABOVE. WHEN PIPE RUNS ARE PERPENDICULAR TO BEAMS, INSTALL PIPING TIGHT TO BOTTOM OF BEAM TO MAXIMIZE SPACE. WHEN PIPE RUNS ARE PARALLEL TO BEAMS, INSTALL PIPING TIGHT TO FLOOR SLAB. PROVIDE ALL NECESSARY TRANSITIONS AND FITTINGS.

R. PROVIDE EXPANSION COMPENSATORS, LOOPS, ANCHORS AND GUIDES FOR ALL PIPING SYSTEMS OPERATING ABOVE AMBIENT CONDITIONS AND INSTALL AS DICTATED BY CODE AND INDUSTRY STANDARDS. EQUIPMENT AND INSTALLATION DETAILS SHALL BE SUBMITTED FOR APPROVAL. THE CONTRACTOR SHALL HIRE AN ENGINEER TO REVIEW DETAILS AND PREPARE COMPLETE DESIGN FOR EXPANSION COMPENSATION SYSTEMS.

S. AIR VENTS SHALL BE PROVIDED AT ALL HIGH POINTS AND DRAINS SHALL BE PROVIDED AT ALL LOW POINTS FOR HYDRONIC SYSTEMS.

T. ALL SUPPLY AND RETURN BRANCH PIPING SHALL BE MINIMUM 3/4" UNLESS OTHERWISE NOTED.

U. PROVIDE BRANCH ISOLATION VALVES OFF OF ALL BUILDING PIPING MAINS ON EACH FLOOR.

V. REFRIGERANT PIPING SHOWN SIZED ON FLOOR PLANS SHALL BE USED AS A GUIDE. THE ACTUAL SIZE AND FITTINGS MAY VARY. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR AND THE MANUFACTURER OF THE EQUIPMENT TO REVIEW THE PIPE SIZING AND MAKE THE NECESSARY ADJUSTMENTS IN SIZES.

W. PROVIDE CLEANOUTS IN ALL MAIN AND BRANCH CONDENSATE PIPING TO ALLOW FOR CLEANING OF ALL PIPING.

LEGEND NOTE

THESE ARE THE GENERAL LEGENDS OF SYMBOLS AND ABBREVIATIONS, AND SHALL BE USED AS A REFERENCE TO DEFINE ITEMS INDICATED ON DRAWINGS. NOT ALL SYMBOLS OR ABBREVIATIONS DEFINED ARE NECESSARILY USED ON THIS PROJECT.

MECHANICAL DEMOLITION NOTES

A. EXISTING MECHANICAL ITEMS THAT ARE BEING DISCONNECTED AND REMOVED SHALL BE DISPOSED OF PROPERLY.

B. NOTIFY CONSTRUCTION MANAGER OF OPENINGS CAUSED BY REMOVAL OF EXISTING EQUIPMENT. ENSURE THE PATCHING IS COMPLETE.

C. REFER TO ARCHITECTURAL DRAWINGS FOR ADDITIONAL RELATED DEMOLITION WORK.

D. REMOVE AND PROPERLY DISPOSE OF EQUIPMENT INCLUDING ELECTRICAL CONNECTIONS BACK TO PANEL.

VANZELM ENGINEERS
VAN ZELM HEYWOOD & SHADFORD, INC.
CT: 860.284.5064 MA: 617.218.9976
10 TALCOTT NOTCH, FARMINGTON, CT 06032 - 1800
Connecticut | Massachusetts | North Carolina

CONSULTANTS:

PROJECT NAME:

Juliet W. Long School
1854 Route 12
Gales Ferry, CT 06335

KEYPLAN

REVISIONS

REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:

MECHANICAL LEGENDS

DATE: 08/05/24
DRAWN BY: JDP/SPM
CHECKED BY: RSM
SCALE: N.T.S.
PROJ #: 2024087.00

DRAWING NUMBER:

M000

1 MECHANICAL PIPING DEMOLITION PLAN
SCALE: 1/8"=1'-0"

VANZELM ENGINEERS
VAN ZELM HEYWOOD & SHADFORD, INC.
CT: 860.284.5064 MA: 617.218.9976
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1854 Route 12
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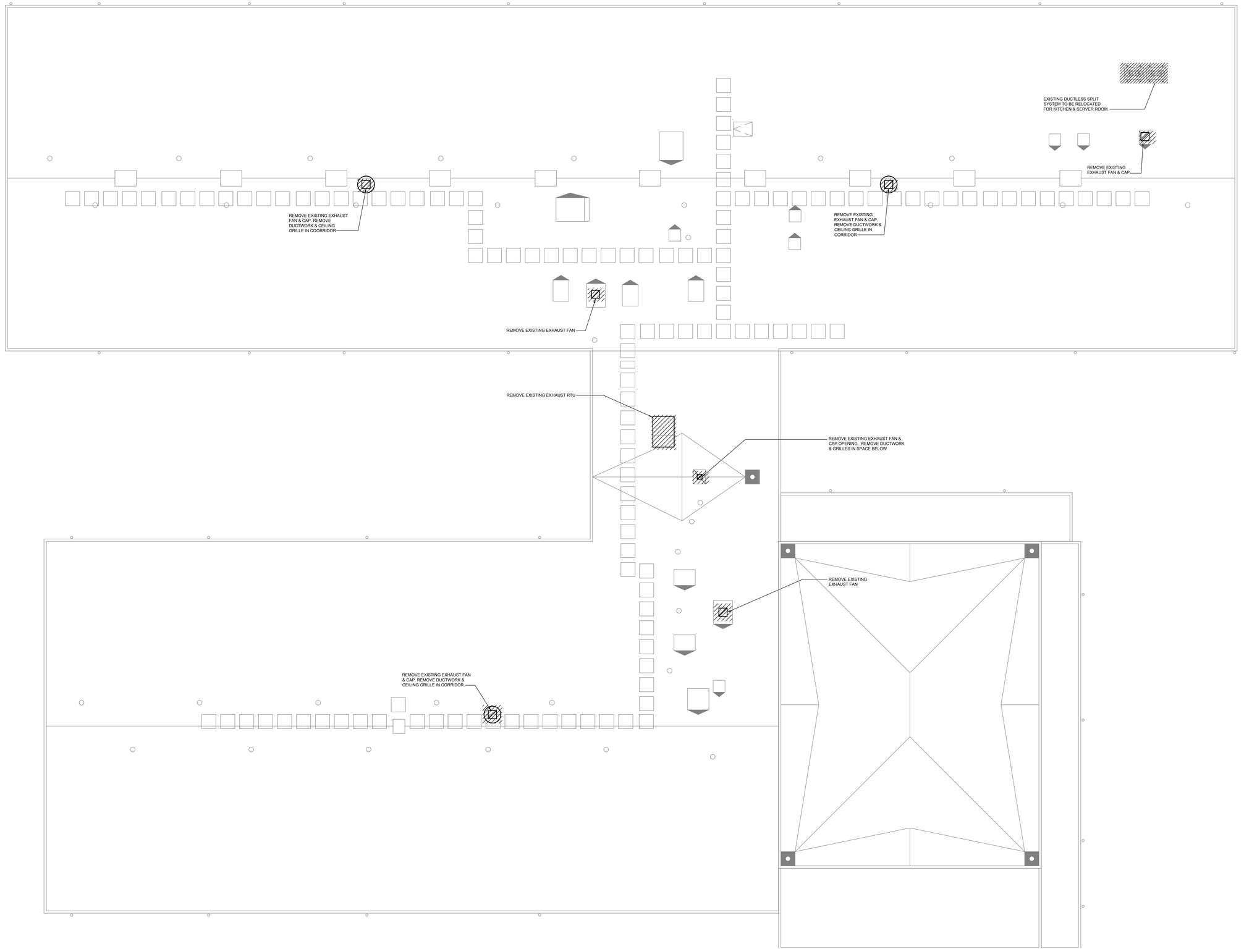
REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:
MECHANICAL PIPING DEMOLITION PLAN

DATE: 08/05/24
DRAWN BY: JDP/SPM
CHECKED BY: RSM
SCALE: 1/8"=1'-0"
PROJ #: 2024087.00

DRAWING NUMBER:
MPD101



1 MECHANICAL ROOF DEMOLITION PLAN
SCALE: 1/8"=1'-0"

VANZELM ENGINEERS
VAN ZELM HEYWOOD & SHADFORD, INC.
CT: 860.284.5064 MA: 617.218.9976
10 TALCOTT NOTCH, FARMINGTON, CT 06032 - 1800
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CONSULTANTS:

PROJECT NAME:
Juliet W. Long School
1854 Route 12
Gales Ferry, CT 06335

KEYPLAN

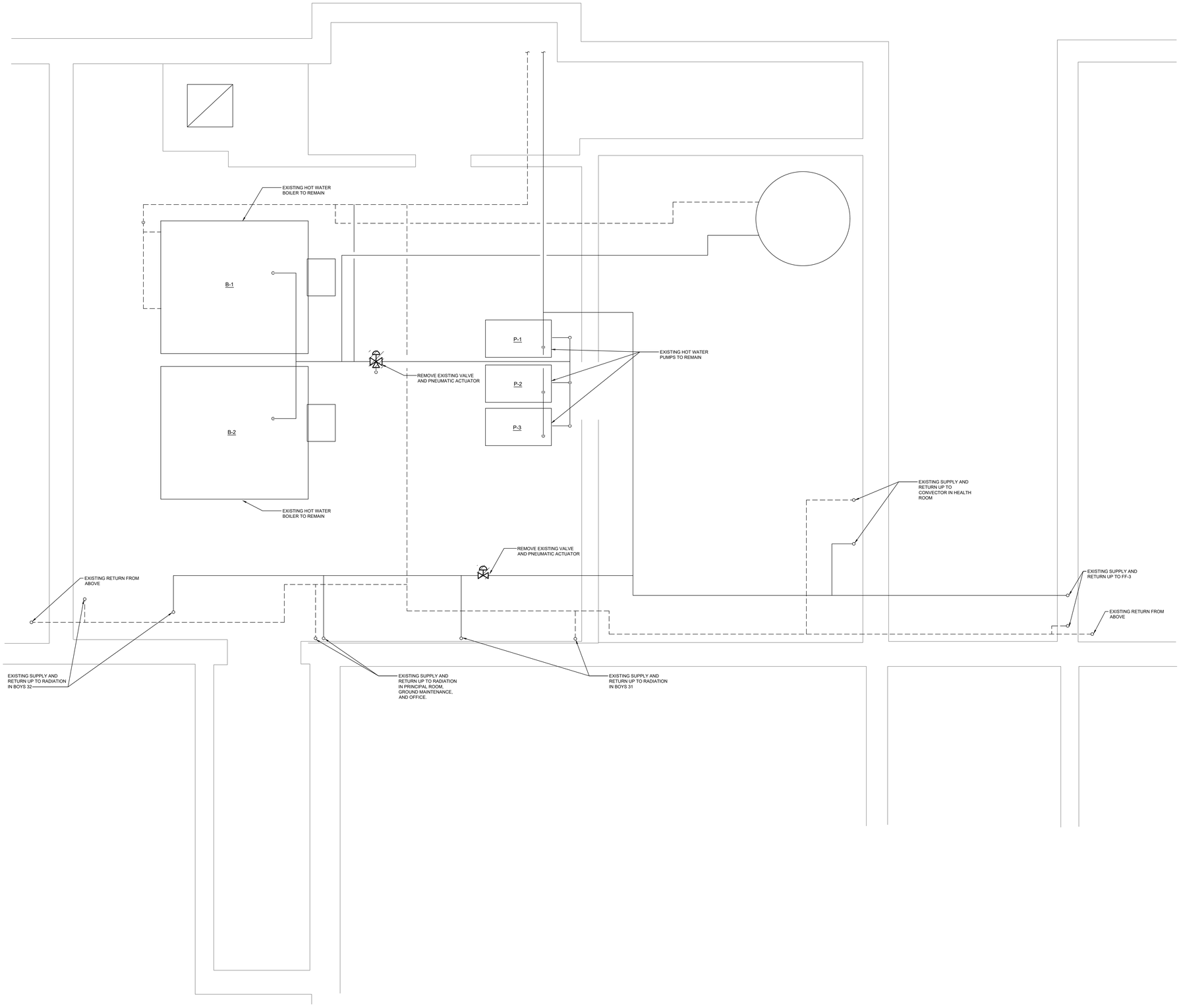
REVISIONS

REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:
MECHANICAL ROOF DEMOLITION PLAN

DATE: 08/05/24
DRAWN BY: JDP/SPM
CHECKED BY: RSM
SCALE: 1/8"=1'-0"
PROJ #: 2024087.00

DRAWING NUMBER:
MD102



1 BOILER ROOM DEMOLITION PLAN
SCALE: 1/2"=1'-0"

VANZELM ENGINEERS
VAN ZELM HEYWOOD & SHADFORD, INC.
CT: 860.284.5064 MA: 617.218.9976
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CONSULTANTS:

PROJECT NAME:
Juliet W. Long School
1854 Route 12
Gales Ferry, CT 06335

KEYPLAN

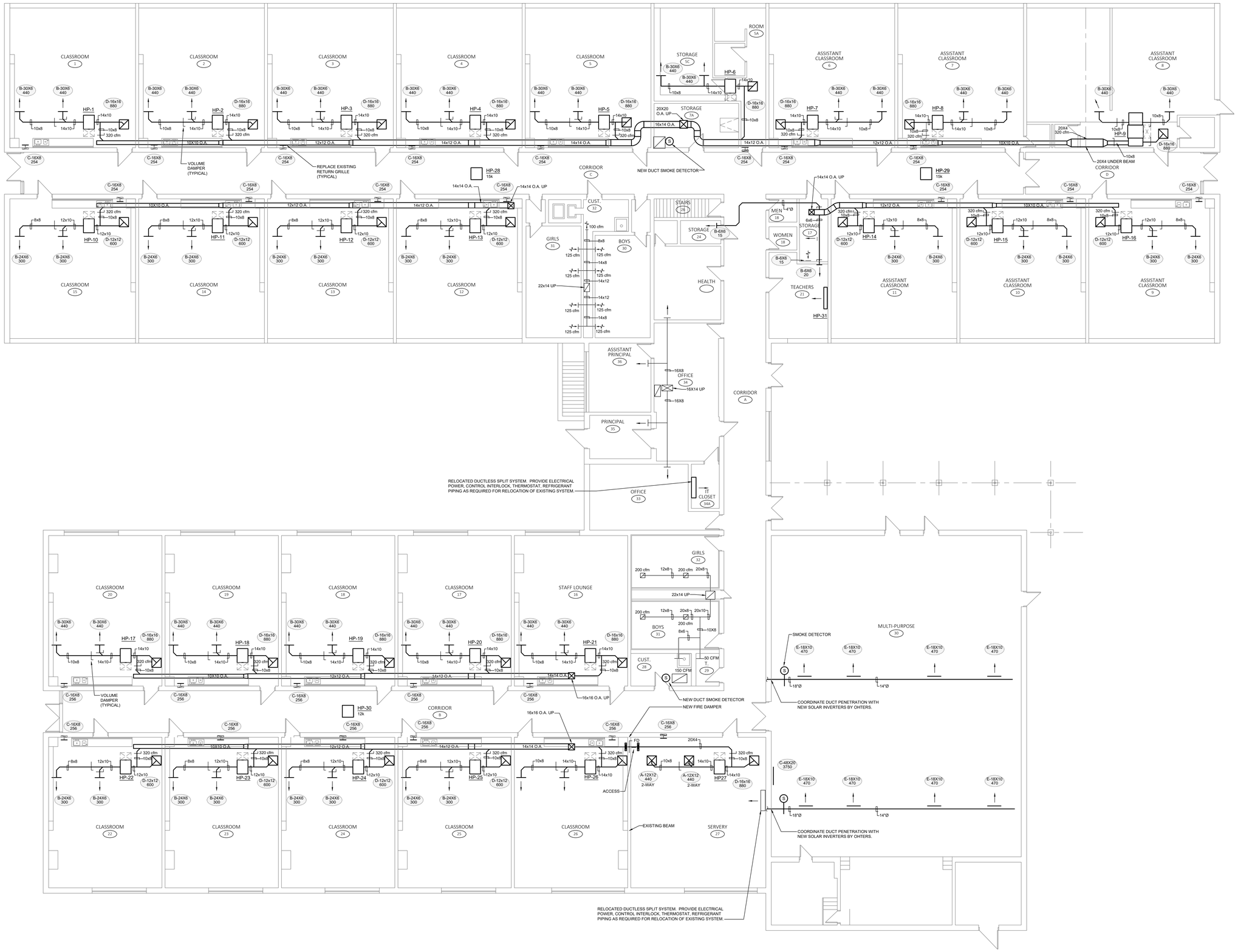
REVISIONS

REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:
BOILER ROOM
DEMOLITION PLAN

DATE: 08/05/24
DRAWN BY: JDP/SPM
CHECKED BY: RSM
SCALE: 1/2"=1'-0"
PROJ #: 2024087.00

DRAWING NUMBER:
MD201



1 MECHANICAL AIR FLOOR PLAN
SCALE: 1/8"=1'-0"

VANZELM ENGINEERS
VAN ZELM HEYWOOD & SHADFORD, INC.
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CONSULTANTS:

PROJECT NAME:
Juliet W. Long School
1854 Route 12
Gales Ferry, CT 06335

KEYPLAN

REVISIONS

REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:
MECHANICAL AIR FLOOR PLAN

DATE: 08/05/24
DRAWN BY: JDP/SPM
CHECKED BY: RSM
SCALE: 1/8"=1'-0"
PROJ #: 2024087.00

DRAWING NUMBER:
MA101

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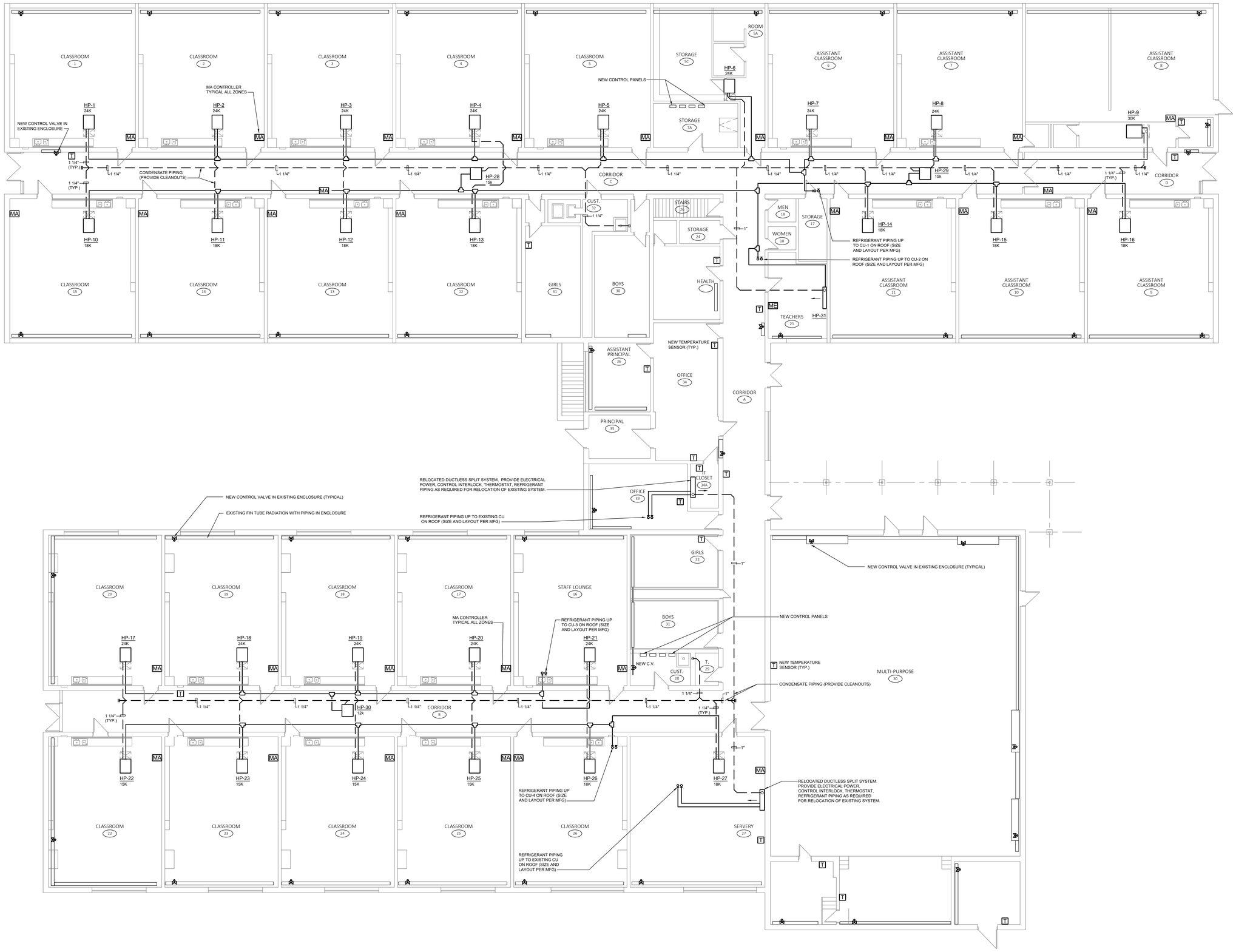

1 MECHANICAL PIPING FLOOR PLAN
SCALE: 1/8"=1'-0"

File Name: Juliet Long Mechanical.dwg 8/5/2024 3:38:39 PM User ID: McKenna, Sean P
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CONSULTANTS:

PROJECT NAME:

Juliet W. Long School
1854 Route 12
Gales Ferry, CT 06335

KEYPLAN

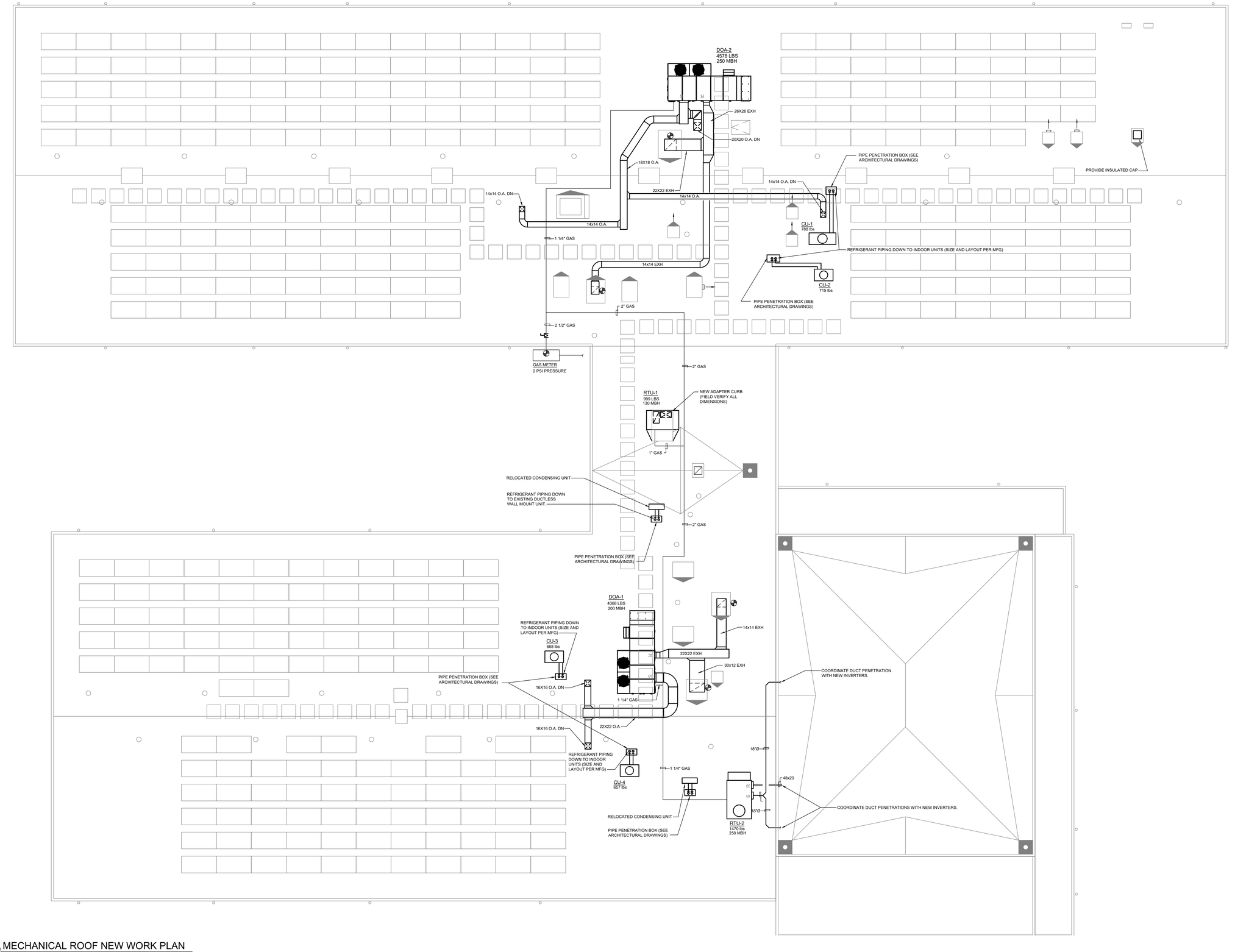
REVISIONS

REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:
MECHANICAL PIPING FLOOR PLAN

DATE:	08/05/24
DRAWN BY:	JDP/SPM
CHECKED BY:	RSM
SCALE:	1/8"=1'-0"
PROJ #:	2024087.00

DRAWING NUMBER:
MP101



1 MECHANICAL ROOF NEW WORK PLAN
SCALE: 1/8"=1'-0"

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File Path: \\vz14\projects\2024\2024087.00\BIM\CAD\Mechanical 3:38:40 PM User ID: McKenna, Sean P

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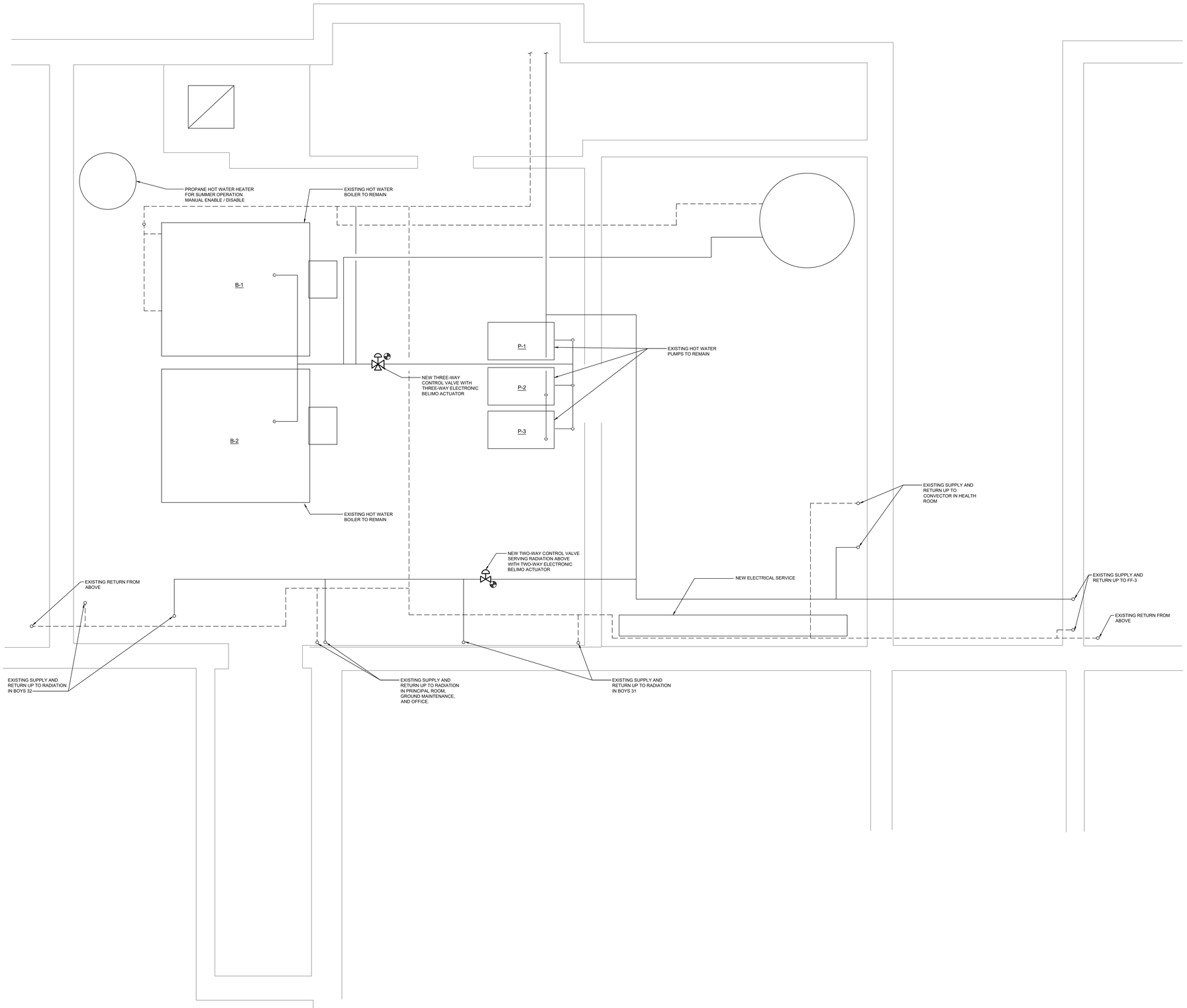
DRAWING TITLE:
MECHANICAL ROOF NEW WORK PLAN

DATE: 08/05/24
DRAWN BY: JDP/SPM
CHECKED BY: RSM
SCALE: 1/8"=1'-0"
PROJ #: 2024087.00

DRAWING NUMBER:
M102



1 BOILER ROOM NEW WORK PLAN
SCALE: 1/2"=1'-0"

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REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:
BOILER ROOM
NEW WORK PLAN

DATE: 08/05/24
DRAWN BY: JDP/SPM
CHECKED BY: RSM
SCALE: 1/2"=1'-0"
PROJ #: 2024087.00

DRAWING NUMBER:
M201

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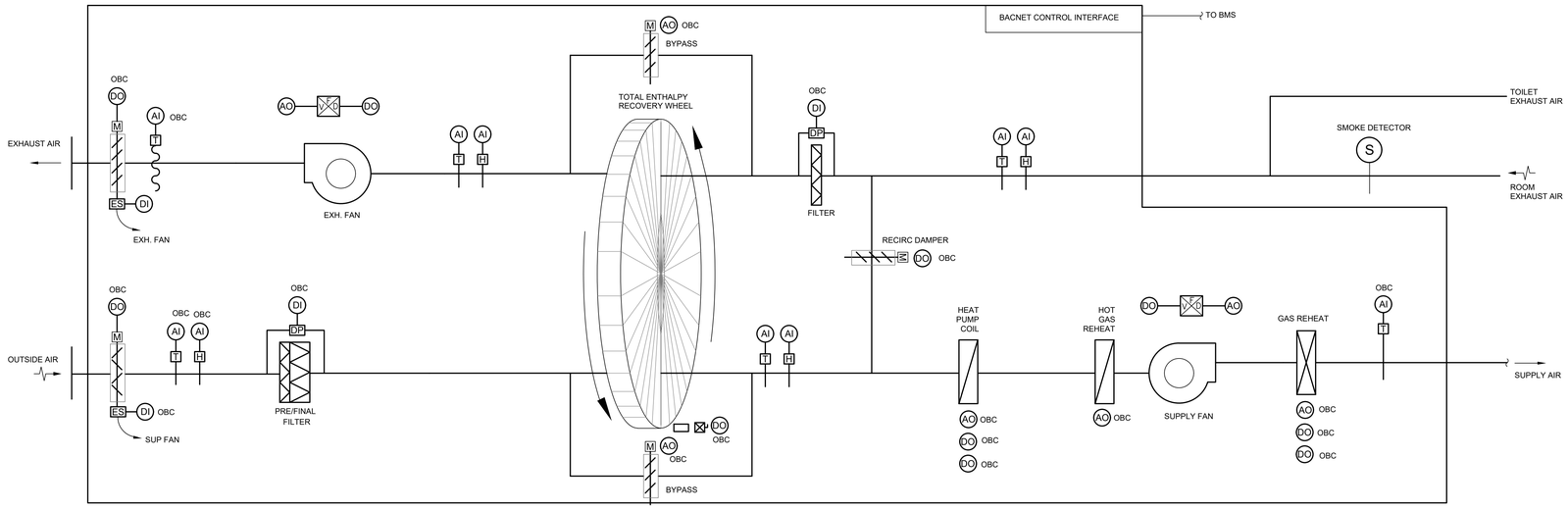

NOTES:

1. BMS SHALL ENABLE UNITS BASED ON TIME SCHEDULE
2. UNIT SHALL SUPPLY 70°F discharge temperature during heating and cooling modes
3. UNIT SHALL BE OFF DURING UN-OCCUPIED PERIODS
4. HOT GAS REHEAT SHALL BE UTILIZED FOR DEHUMIDIFCATION
5. BMS SHALL PROVIDE FOLLOWING ALARMS (EITHER HARD WIRED OR VIA BACNET)
   - A - FAN FAILURE
   - B - DAMPER FAILURE
   - D - HIGH HUMIDITY
   - E - VFD FAULT (SUPPLY & RETURN FAN & WHEEL)
   - F - FILTER DIRTY
   - G - WHEEL FAILURE
   - H - COMPRESSOR FAILURE
   - I - GAS HEAT ALARM
   - J - HIGH / LOW DISCHARGE AIR TEMP

1. BMS SHALL INTERFACE WITH DOA SYSTEM VIA BACNET. COORDINATE WITH DOA MFG & OWNER TO DETERMINE THE NUMBER OF POINTS NEEDED TO SATISFY CONTROL SEQUENCE AND PROVIDE ADEQUATE MONITORING FOR MAINTENANCE PERSONNEL .

BMS
AI AI
H T
OUTDOOR TEMP & HUMIDITY SENSOR

CONTROLS LEGEND

AO	ANALOG OUTPUT
AI	ANALOG INPUT
DO	DIGITAL OUTPUT
DI	DIGITAL INPUT
T	TEMPERATURE SENSOR
S	SMOKE DETECTOR
DP	DIFFERENTIAL PRESSURE SENSOR
H	HUMIDITY SENSOR
LT	FREEZE PROTECTION THERMOSTAT
P	STATIC PRESSURE SENSOR
T	PNEUMATIC THERMOSTAT
T	ELECTRIC THERMOSTAT
	MOTOR STARTER
	VARIABLE FREQUENCY DRIVE
GWS	GLYCOL WATER SUPPLY
GWR	GLYCOL WATER RETURN
GS	GLYCOL SUPPLY
GR	GLYCOL RETURN
STM	STEAM SUPPLY
CS	CURRENT SENSOR
CO2	CARBON DIOXIDE SENSOR
BMS	BUILDING MANAGEMENT SYSTEM POINT
OBC	ON BOARD CONTROLLER POINT

1 HEAT RECOVERY AIR HANDLING UNIT CONTROL DIAGRAM (DOA#)
SCALE: N.T.S.

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KEYPLAN

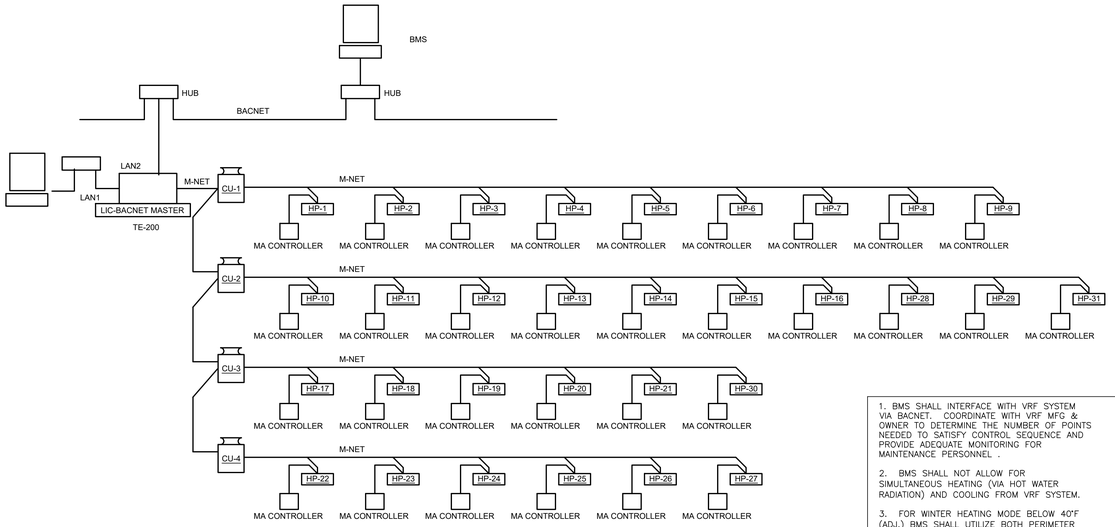
REVISIONS

REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:
MECHANICAL CONTROLS

DATE: 08/05/24
DRAWN BY: JDP/SPM
CHECKED BY: RSM
SCALE: N.T.S.
PROJ #: 2024087.00

DRAWING NUMBER:
M300

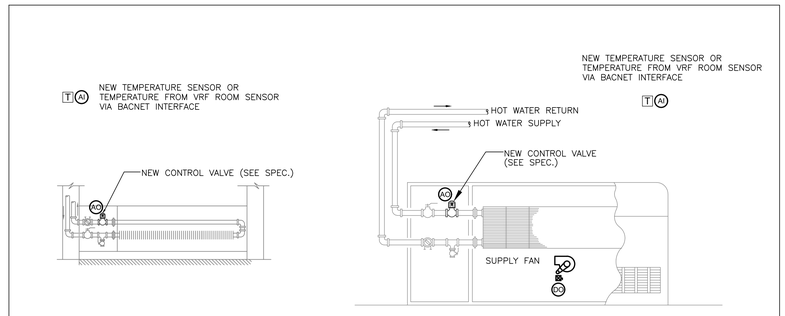


1. BMS SHALL INTERFACE WITH VRF SYSTEM VIA BACNET. COORDINATE WITH VRF MFG & OWNER TO DETERMINE THE NUMBER OF POINTS NEEDED TO SATISFY CONTROL SEQUENCE AND PROVIDE ADEQUATE MONITORING FOR MAINTENANCE PERSONNEL .

2. BMS SHALL NOT ALLOW FOR SIMULTANEOUS HEATING (VIA HOT WATER RADIATION) AND COOLING FROM VRF SYSTEM.

3. FOR WINTER HEATING MODE BELOW 40°F (ADJ.) BMS SHALL UTILIZE BOTH PERIMETER RADIATION AND HEAT PUMP TO SATISFY THE SPACE TEMPERATURE SENSOR. THE NEW RADIATION CONTROL VALVES SHALL BE MODULATED FROM (0-5V ADJ.) TO ACHIEVE HEATING FROM BOTH SOURCES. FIELD CALIBRATION WILL BE REQUIRED TO DETERMINE CONTROL VALVE RANGE SETTINGS.

1 CLASSROOM HEAT PUMP CONTROLS
SCALE: N.T.S.



2 EXISTING RADIATION & CUH CONTROLS
SCALE: N.T.S.

NEW CONTROL SYSTEM NOTES:

1. EXISTING CONTROL SYSTEM IN BUILDING IS PNEUMATIC. ALL EXISTING PNEUMATIC CONTROLS SHALL BE REPLACED WITH NEW DDC CONTROLS.
2. NEW CONTROL SYSTEM SHALL BE BY HONEYWELL, DISTEC OR TRANE-LynxSpring (NIAGARA BASED) .
3. NEW CONTROL SYSTEM SHALL INCLUDE HEAD END. IF HONEYWELL IS CHOSEN THE EXISTING SYSTEM IN THE ADJACENT BUILDING CAN BE EXPANDED AS REQUIRED.

NOTES:

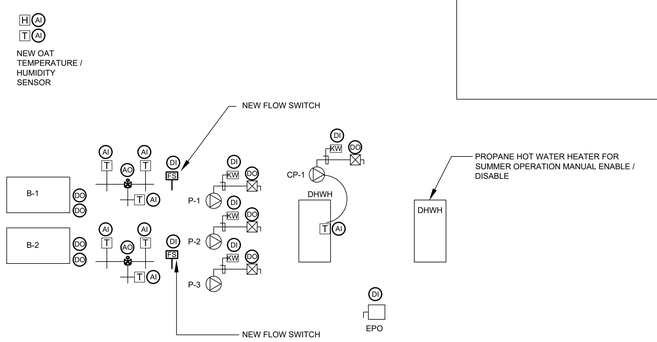
1. CONTROL SYSTEM SHALL ENABLE ONE BOILER MAX DUE TO THE ADDITION OF GAS HEAT AND HEAT PUMP OPERATION.

2. BOILERS SHALL BE ENABLED IN LEAD/LAG SEQUENCE.

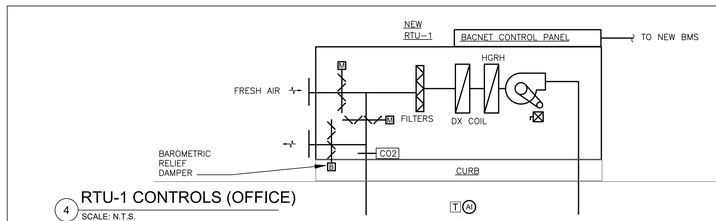
3. 3-WAY VALVES SHALL MODULATE TO MAINTAIN HOT WATER SUPPLY TEMPERATURE SETPOINT AS DETERMINED BY O.A. RESET SCHEDULE

4. IF PUMP FAILS AS SENSED BY FLOW SWITCH, ENABLE STANDBY PUMP.

5. ALARMS
- HIGH/LOW HOT WATER SUPPLY TEMP.
- PUMP FAILURE
- BURNER ALARM

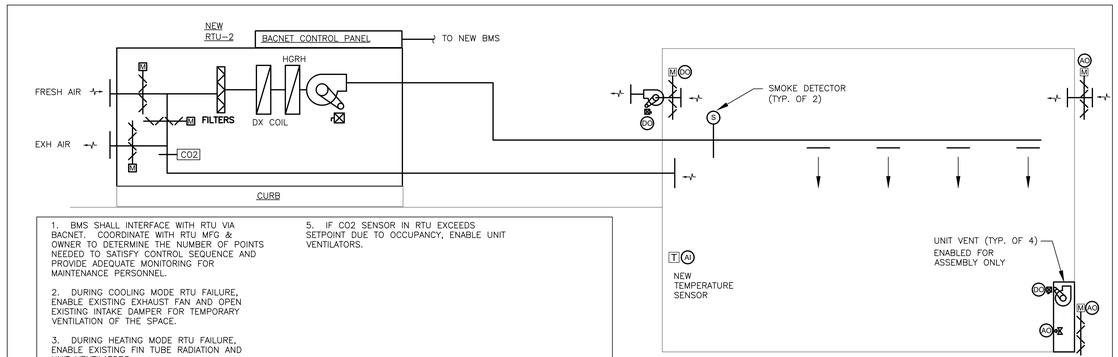


3 BOILER ROOM
SCALE: N.T.S.



1. BMS SHALL INTERFACE WITH RTU VIA BACNET. COORDINATE WITH RTU MFG & OWNER TO DETERMINE THE NUMBER OF POINTS NEEDED TO SATISFY CONTROL SEQUENCE AND PROVIDE ADEQUATE MONITORING FOR MAINTENANCE PERSONNEL.

4 RTU-1 CONTROLS (OFFICE)
SCALE: N.T.S.



1. BMS SHALL INTERFACE WITH RTU VIA BACNET. COORDINATE WITH RTU MFG & OWNER TO DETERMINE THE NUMBER OF POINTS NEEDED TO SATISFY CONTROL SEQUENCE AND PROVIDE ADEQUATE MONITORING FOR MAINTENANCE PERSONNEL.

2. DURING COOLING MODE RTU FAILURE, ENABLE EXISTING EXHAUST FAN AND OPEN EXISTING INTAKE DAMPER FOR TEMPORARY VENTILATION OF THE SPACE.

3. DURING HEATING MODE RTU FAILURE, ENABLE EXISTING FIN TUBE RADIATION AND UNIT VENTILATORS.

4. FOR WINTER HEATING MODE BELOW 40°F (ADJ.) BMS SHALL UTILIZE BOTH PERIMETER RADIATION AND RTU (GAS HEAT) TO SATISFY THE SPACE TEMPERATURE SENSOR. THE NEW RADIATION CONTROL VALVES SHALL BE MODULATED FROM (0-5V ADJ.) TO ACHIEVE HEATING FROM BOTH SOURCES. FIELD CALIBRATION WILL BE REQUIRED TO DETERMINE CONTROL VALVE RANGE SETTINGS.

5. IF CO2 SENSOR IN RTU EXCEEDS SETPOINT DUE TO OCCUPANCY, ENABLE UNIT VENTILATORS.

5 RTU-2 CONTROLS (GYM)
SCALE: N.T.S.

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REVISIONS

REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:
MECHANICAL CONTROLS

DATE: 08/05/24	DRAWING NUMBER: M301
DRAWN BY: JDP/SPM	
CHECKED BY: RSM	
SCALE: N.T.S.	
PROJ #: 2024087.00	

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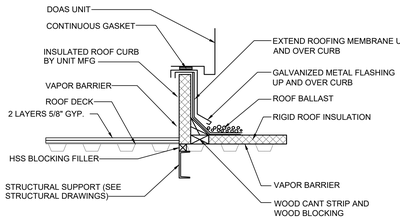
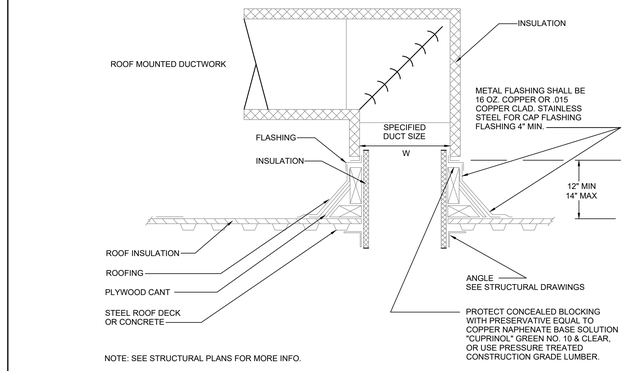
GENERAL NOTES

1. FLOOR PLANS ARE DIAGRAMMATIC ONLY. CONTRACTOR SHALL PERFORM DETAILED SITE VISIT PRIOR TO BIDDING JOB TO LOOK ABOVE CEILINGS WHERE NEW DUCTWORK AND PIPING IS RUN.
2. BALANCING CONTRACTOR SHALL PROVIDE AIR BALANCING ON ALL EXISTING AND NEW REGISTERS AND ALL NEW FANS. BALANCING CONTRACTOR SHALL PROVIDE WATER BALANCING ON ALL EXISTING AND NEW EQUIPMENT. BALANCING CONTRACTOR SHALL WORK WITH CONTROLS CONTRACTOR AS REQUIRED FOR USING VFD'S SETTINGS TO SATISFY AIRFLOW REQUIREMENTS.
3. ROOF MOUNTED DUCTWORK AND EQUIPMENT SHALL BE COORDINATED WITH EXISTING SOLAR PANELS, POWER WIRING, ROOF DRAINS AND PLUMBING VENTS.
4. SEE STRUCTURAL PLANS FOR EXACT LOCATIONS OF UNITS.



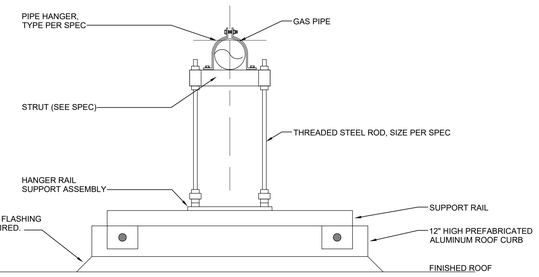
NOTE: SEE STRUCTURAL PLANS FOR MORE INFO.

1 DOAS & RTU CURB DETAIL
SCALE: NOT TO SCALE

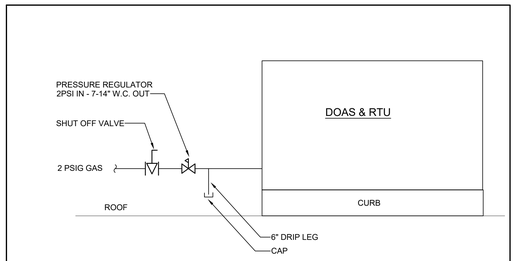


NOTE: SEE STRUCTURAL PLANS FOR MORE INFO.

2 ROOF DUCT PENETRATION DETAIL
SCALE: NOT TO SCALE



3 ROOF MOUNTED PIPE SUPPORT DETAIL
SCALE: NOT TO SCALE



4 DOAS/RTU GAS PIPING DETAIL
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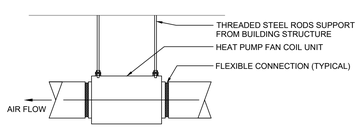
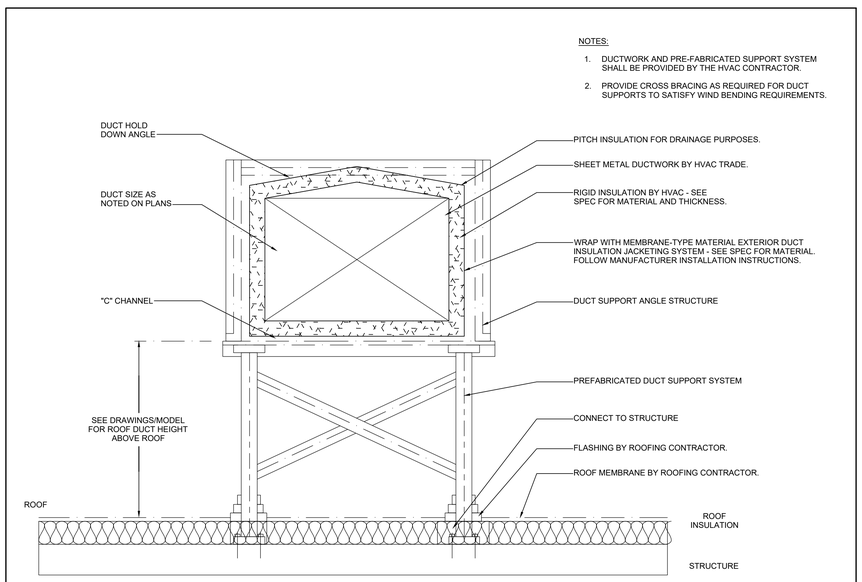
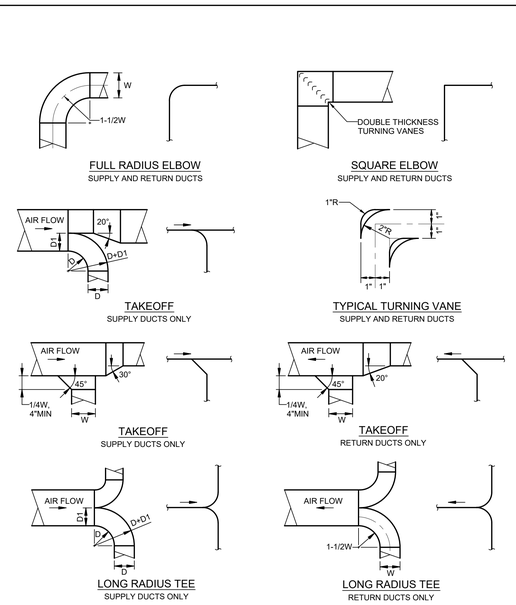


WRAP WITH MEMBRANE-TYPE MATERIAL EXTERIOR DUCT INSULATION JACKETING SYSTEM - SEE SPEC FOR MATERIAL. FOLLOW MANUFACTURER INSTALLATION INSTRUCTIONS.

5 INDOOR HEAT PUMP DETAIL
SCALE: NOT TO SCALE



6 ROOF MOUNTED DUCTWORK DETAIL
SCALE: NOT TO SCALE



7 TYPICAL DUCT DETAILS WITH SINGLE LINE REPRESENTATION
SCALE: NOT TO SCALE

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DRAWING TITLE:
MECHANICAL DETAILS

DATE: 08/05/24
DRAWN BY: JDP/SPM
CHECKED BY: RSM
SCALE: N.T.S.
PROJ #: 2024087.00

DRAWING NUMBER:
M400

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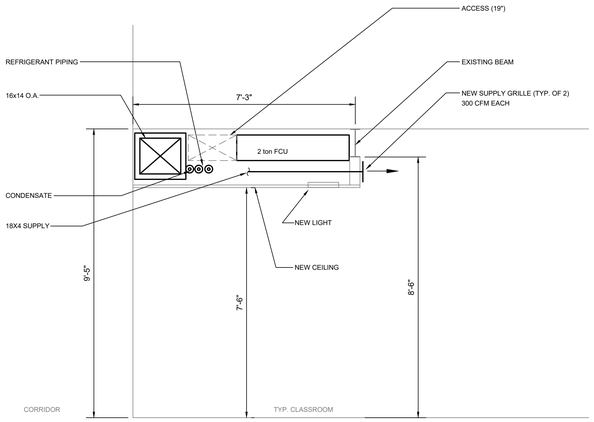
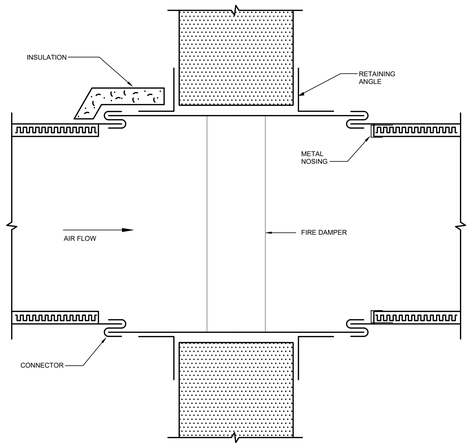


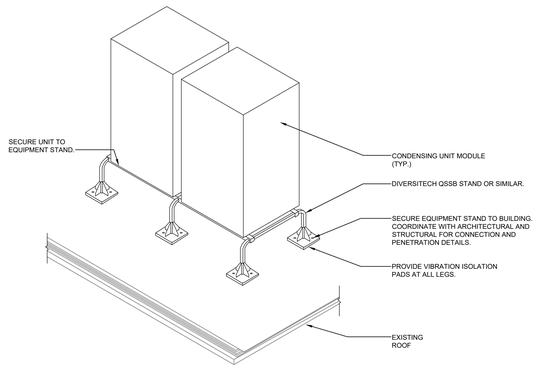
1 TYPICAL CLASSROOM SECTION
SCALE: N.T.S.



2 HORIZONTAL FIRE DAMPER DETAIL
SCALE: N.T.S.

NOTES:

1. OPENING IN FLOOR SHALL BE A MINIMUM OF 1/8" PER FOOT LARGER THAN OVERALL SIZE OF DAMPER AND SLEEVE ASSEMBLY FOR GALVANIZED STEEL DAMPERS. MAXIMUM OPENING NOT TO EXCEED 1/8" PER FOOT PLUS ONE INCH FOR GALVANIZED STEEL DAMPERS. OPENING SHALL NOT BE LESS THAN 1/4" LARGER FOR ANY SIZE DAMPER AND SLEEVE ASSEMBLY.
2. MOUNTING ANGLES SHALL BE A MINIMUM OF 1-1/2" x 1-1/2" x 1/4" AND FASTENED WITH #10 BOLTS OR SCREWS, 1/2" LG. WELDS, OR 3/16" RIVETS TO SLEEVE AT A MAXIMUM SPACING OF 6" WITH A MINIMUM OF TWO CONNECTIONS IN EACH SIDE, TOP AND BOTTOM.
3. WHEN MULTIPLE DAMPER ASSEMBLIES ARE JOINED OR FASTENING DAMPER TO SLEEVE, DAMPERS SHALL BE FASTENED WITH NO. 10 BOLT OR SCREWS, 3/16" RIVET OR 1/2" LG. WELD STAGGERED INTERMITTENTLY, AND SPACED 12" MAXIMUM C-C.



3 VRF CONDENSING UNIT MOUNTING DETAIL
SCALE: N.T.S.

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REVISIONS

REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:
MECHANICAL
DETAILS

DRAWING NUMBER:
M401

DATE: 08/05/24
DRAWN BY: JDP/SPM
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PROJ #: 2024087.00

ROOFTOP UNIT SCHEDULE

AIR HANDLING UNIT DATA								SUPPLY FAN DATA						DX COIL DATA							HOT GAS REHEAT DATA					GAS HEAT SECTION DATA			ELEC DATA						REMARKS
UNIT NO.	LOCATION	SERVING	MANUFACTURER	MODEL & SIZE	TOTAL CFM	MIN. O.A. CFM	OPERATING WEIGHT	FAN TYPE	E.S.P. "WC	T.S.P. "WC	RPM	BHP	MHP	AMBIENT D.B. °F	E.D.B. °F	E.W.B. °F	L.D.B. °F	L.W.B. °F	MBH (TOTAL)	MBH (SENS.)	MBH (TOTAL)	E.D.B. °F	L.D.B. °F	LEAVING DEW POINT °F	MOISTURE REMOVAL GPH	E.D.B. °F	L.D.B. °F	MBH IN/OUT	EFF.	VOLTS	PH	HZ	MCA	MOCP	
RTU-1	ROOF	OFFICE	TRANE	PRECEDENT -YHC060	2000	200	999.0 LBS	DIRECT DRIVE	1.000	1.320	1169	1.120	1.000	95.00	80.00	67.00	58.09	56.71	59.87	43.70	38.24	58.09	75.71	55.82	1.83 GPH	70.00	118.40	130/107.63	82%	208	3	60	26	40	SEE NOTES 1-12
RTU-2	ROOF	GYM	TRANE	YHJ150B3S0H	3750	1293	1470 LBS	DIRECT DRIVE	1.5"	1.76"	1169	1.120	4.6	95.00	80.00	67.00	55.8	54.8	139	93	86.5	54.8	71	50.38	6.1 GPH	60	108	250/202	82%	208	3	60	67	90	SEE NOTES 1-12

NOTES:
1. PREMIUM EFFICIENCY MOTOR.
2. PROVIDE COATED CONDENSER COILS DUE TO COASTAL PROXIMITY
3. GAS HEAT.
4. NON-FUSED DISCONNECT SWITCH. FUSED SWITCH BY ELECTRICAL
5. PROVIDE START-UP SERVICES & PROGRAMMING.
6. OUTSIDE AIR ECONOMIZER.
7. C02 DEMAND CONTROL VENTILATION.
8. INSTALL PER MANUFACTURER'S RECOMMENDATIONS.
9. HOT GAS REHEAT FOR DEHUMIDIFCATION
10. 24" STRUCTURAL CURB FOR RTU-2 (CONTRACTOR TO VERIFY HEIGHT PRIOR TO ORDERING)
11. PROVIDE UNIT MOUNTED AND POWERED CONVENIENCE OUTLET.
12. SUBMITTAL PACKAGE SHALL INCLUDE A COMPLETE CONTROL DIAGRAM, LIST OF FACTORY HARD-WIRED POINTS, LIST OF INSTALLED BACNET POINTS AND ANY CONTROL REQUIRED BY A 3RD PARTY BMS SYSTEM TO ACCOMMODATE ALL CONTROL SEQUENCES ON CONTRACT DOCUMENTS.

WARRANTY
1. RTU-Office: 1 year parts, 5 year compressor
2. RTU-Gym: 3 year parts, 5 year compressor

RTU-1 - THIS UNIT IS REPLACING AN EXISTING RTU
EXISTING UNIT INFO: CARRIER MODEL - 50TJ 005 501 SERIAL - 2894G20167
ADDITIONAL FEATURES OF NEW UNIT: HOT GAS REHEAT & DEMAND CONTROL VENTILATION
PROVIDE ADAPTER CURB AS REQUIRED.

DEDICATED OUTDOOR AIR SYSTEM SCHEDULE

AIR HANDLING UNIT DATA							SUPPLY FAN DATA							EXHAUST FAN DATA							HEAT PUMP COOLING DATA								HEAT PUMP HEATING DATA				HOT GAS REHEAT COIL DATA				
UNIT NO.	LOCATION	SERVING	MANUFACTURER	MODEL & SIZE	TOTAL CFM	WEIGHT	FAN TYPE	E.S.P. "WC	T.S.P. "WC	RPM	SPEED CONTROL	BHP	MHP	FAN TYPE	TOTAL CFM	E.S.P. "WC	T.S.P. "WC	RPM	SPEED CONTROL	BHP	MHP	EVAPORATOR ROWS / F.P.I.	CONDENSER ROWS / F.P.I.	E.D.B. °F	E.W.B. °F	L.D.B. °F	L.W.B. °F	GROSS MBH (TOTAL)	GROSS MBH (SENS.)	FACE VEL FPM	A.P.D. "WC	O.A.T. °F	E.D.B. °F	L.D.B. °F	MBH (TOTAL)	E.D.B. °F	E.W.B. °F	L.D.B. °F	L.W.B. °F	A.P.D. "WC
DOA-1	ROOF	LOWER WING	TRANE	OADG017F1	3,825	4,368	PLENUM	1.5	3.35	1,856	VFD	2.86	5	PLENUM	4,029	1.0	2.18	2,113	VFD	2.27	3	6 / 14	3 / 12	78.7	66.5	48.2	47.9	200.9	125.8	220	0.23	9.0	44.9	76.0	140.8	48.2	47.9	75.6	59.29	0.03
DOA-2	ROOF	UPPER WING	TRANE	OADG020F1	5,160	4,578	PLENUM	1.5	3.60	1,534	VFD	5.02	7.5	PLENUM	5,420	1.0	1.94	1,507	VFD	2.55	5	6 / 14	3 / 12	78.1	65.9	50.1	49.9	236.4	155.8	297	0.34	9.0	48.7	72.1	147.1	50.1	49.9	74.8	59.92	0.05

DEDICATED OUTDOOR AIR SYSTEM SCHEDULE (CONTINUED)

GAS FURNACE DATA						ENERGY WHEEL DATA										FILTERS			ELECTRICAL SINGLE POINT POWER				REMARKS
UNIT NO.	E.A.T. °F	L.A.T. °F	A.P.D. "WC	MBH IN	MBH OUT	SUMMER CONDITIONS					WINTER CONDITIONS					PREFILTER TYPE	PRIMARY FILTER TYPE	A.P.D. "WC	VOLT/HZ/PH.	MCA	MOP	FLA	
						O.A. D.B./W.B. (°F)	R.A. D.B./W.B. (°F)	S.A. D.B./W.B. (°F)	E.A. D.B./W.B. (°F)	RECOVERY (BTU/H)	O.A. D.B./W.B. (°F)	R.A. D.B./W.B. (°F)	S.A. D.B./W.B. (°F)	E.A. D.B./W.B. (°F)	RECOVERY (BTU/H)								
DOA-1	44.9	83.5	0.37	200	160	85.0/72.0	75.0/62.5	78.7/66.5	81.1/68.4	75,310.0	9.0/5.0	68.0/57.0	44.9/40.3	32.1/30.4	225,940.0	2" MERV 8	2" MERV 13	0.18	208/60/3	98.4	125	91.5	SEE NOTES 1-12
DOA-2	48.7	84.9	0.53	250	202.5	85.0/72.0	75.0/62.5	78.1/65.9	81.8/69.0	112,810.0	9.0/5.0	68.0/57.0	48.7/43.3	28.3/26.9	337,780.0	2" MERV 8	2" MERV 13	0.33	208/60/3	111.8	125	104.7	SEE NOTES 1-12

NOTES:
1. MANUFACTURER 1-YEAR PARTS ONLY WARRANTY. DIGITAL SCROLL COMPRESSOR 5-YEAR WARRANTY. FURNACE HX WARRANTY 25-YEARS.
2. DOUBLE WALL, R13 CONSTRUCTION.
3. STAINLESS STEEL CONDENSATE DRAIN PAN.
4. BACNET MSTP CONTROL INTERFACE.
5. FROST CONTROL AND BYPASS REQUIRED FOR ENERGY WHEEL.
6. HORIZONTAL DUCT CONNECTIONS.
7. INSULATED ENCLOSURE FOR PIPING CONNECTIONS.
8. NON-FUSED DISCONNECT SWITCH.
9. PROVIDE COATED CONDENSER COILS DUE TO COASTAL PROXIMITY
10. 24" STRUCTURAL CURBS (VERIFY HEIGHT WITH NEW ROOFING INSULATION) CONTRACTOR TO VERIFY HEIGHT PRIOR TO ORDERING
11. PROVIDE UNIT MOUNTED AND POWERED CONVENIENCE OUTLET.
12. SUBMITTAL PACKAGE SHALL INCLUDE A COMPLETE CONTROL DIAGRAM, LIST OF FACTORY HARD-WIRED POINTS, LIST OF INSTALLED BACNET POINTS AND ANY CONTROL REQUIRED BY A 3RD PARTY BMS SYSTEM TO ACCOMMODATE ALL CONTROL SEQUENCES ON CONTRACT DOCUMENTS.

OUTDOOR VRF CONDENSING UNIT SCHEDULE

UNIT NO.	MANUFACTURER	MODEL & SIZE	TOTAL CAPACITY (BTU/H)		OUTDOOR TEMP (°F)			EFFICIENCY		REFRIGERANT	POWER SUPPLY					SOUND POWER	REMARKS
			TOTAL COOLING	TOTAL HEATING	COOLING DBT	COOLING WBT	HEATING DBT	COOLING IEER (SEER)	HEATING COP (HSPF)		VOLTS	PHASE	HZ	MCA (A)	MOP (A)		
CU-1	TRANE	TUHYE1923AN41AN	192,000	215,000	95.0	-	-	21.7	3.775	R410A	208	3	60	80	125	-	SEE NOTES 1,2,3
CU-2	TRANE	TUHYE1443AN41AN	144,000	160,000	95.0	-	-	22.2	3.845	R410A	208	3	60	60	100	-	SEE NOTES 1,2,3
CU-3	TRANE	TUHYE1203AN41AN	120,000	135,000	95.0	-	-	23.35	4.005	R410A	208	3	60	55	90	-	SEE NOTES 1,2,3
CU-4	TRANE	TUHYE0963AN41AN	96,000	108,000	95.0	-	-	25.0	4.215	R410A	208	3	60	44	70	-	SEE NOTES 1,2,3

NOTES:
1. MANUFACTURER 1-YEAR PARTS ONLY WARRANTY. DIGITAL SCROLL COMPRESSOR 5-YEAR WARRANTY.
2. MINIMUM ASTM B117 SALT SPRAY TEST STANDARD FOR 2000HRS FOR CONDENSING UNITS.
3. PROVIDE 24" HIGH SUPERSTAND (CONTRACTOR TO VERIFY HEIGHT PRIOR TO ORDERING)
4. SUBMITTAL PACKAGE SHALL INCLUDE A COMPLETE CONTROL DIAGRAM, LIST OF FACTORY HARD-WIRED POINTS, LIST OF INSTALLED BACNET POINTS AND ANY CONTROL REQUIRED BY A 3RD PARTY BMS SYSTEM TO ACCOMMODATE ALL CONTROL SEQUENCES ON CONTRACT DOCUMENTS.

DIFFUSER & REGISTER SCHEDULE

TYPE	MANUFACTURER	MODEL & SIZE	FUNCTION	DESCRIPTION	REMARKS
A	PRICE	PDN	SUPPLY	ALUMINUM SQUARE DIFFUSER	SEE NOTES 1,2,3,4
B	PRICE	610	SUPPLY	ALUMINUM LOUVERED GRILLE	SEE NOTES 1,3,4
C	PRICE	610	RETURN/EXH	ALUMINUM LOUVERED GRILLE	SEE NOTES 1,3,4
D	PRICE	80	EXHAUST/TRANSFER	ALUMINUM EGG CRATE GRILLE	SEE NOTES 1,3,4
E	PRICE	AHCD2	SUPPLY	DRUM LOUVER	SEE NOTES 1,3,4

NOTES:
1. ALL NECK SIZES ARE NOTED ON DRAWINGS.
2. THROW PATTERNS ARE 4-WAY UNLESS NOTED OTHERWISE.
3. PROVIDE OPPOSED BLADE DAMPER.
4. COLOR BY ARCHITECT.

VRF INDOOR UNIT SCHEDULE

UNIT NO.	SERVED BY	LOCATION	MANUFACTURER	MODEL & SIZE	TOTAL CAPACITY (BTU/H)		INDOOR TEMP (°F)			POWER SUPPLY					REMARKS
					TOTAL COOLING	TOTAL HEATING	COOLING DBT	COOLING WBT	HEATING DBT	VOLTS	PHASE	HZ	MCA (A)	MOP (A)	
HP-1	CU-1	CLASSROOM 1	TRANE	TPEFYP024MA144A	24,000	27,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-2	CU-1	CLASSROOM 2	TRANE	TPEFYP024MA144A	24,000	27,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-3	CU-1	CLASSROOM 3	TRANE	TPEFYP024MA144A	24,000	27,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-4	CU-1	CLASSROOM 4	TRANE	TPEFYP024MA144A	24,000	27,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-5	CU-1	CLASSROOM 5	TRANE	TPEFYP024MA144A	24,000	27,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-6	CU-1	CLASSROOM 6	TRANE	TPEFYP024MA144A	24,000	27,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-7	CU-1	CLASSROOM 8	TRANE	TPEFYP024MA144A	24,000	27,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-8	CU-1	CLASSROOM 9	TRANE	TPEFYP024MA144A	24,000	27,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-9	CU-1	KINDERGARTEN 10	TRANE	TPEFYP030MA144A	30,000	34,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-10	CU-2	CLASSROOM 37	TRANE	TPEFYP018MA144A	18,000	20,000	75.0	62.5	70.0	208	1	60	2.94	15	SEE NOTES 1-4
HP-11	CU-2	CLASSROOM 36	TRANE	TPEFYP018MA144A	18,000	20,000	75.0	62.5	70.0	208	1	60	2.94	15	SEE NOTES 1-4
HP-12	CU-2	CLASSROOM 35	TRANE	TPEFYP018MA144A	18,000	20,000	75.0	62.5	70.0	208	1	60	2.94	15	SEE NOTES 1-4
HP-13	CU-2	CLASSROOM 34	TRANE	TPEFYP018MA144A	18,000	20,000	75.0	62.5	70.0	208	1	60	2.94	15	SEE NOTES 1-4
HP-14	CU-2	CLASSROOM 16	TRANE	TPEFYP018MA144A	18,000	20,000	75.0	62.5	70.0	208	1	60	2.94	15	SEE NOTES 1-4
HP-15	CU-2	CLASSROOM 15	TRANE	TPEFYP018MA144A	18,000	20,000	75.0	62.5	70.0	208	1	60	2.94	15	SEE NOTES 1-4
HP-16	CU-2	CLASSROOM 14	TRANE	TPEFYP018MA144A	18,000	20,000	75.0	62.5	70.0	208	1	60	2.94	15	SEE NOTES 1-4
HP-17	CU-3	CLASSROOM 1A	TRANE	TPEFYP024MA144A	24,000	27,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-18	CU-3	CLASSROOM 2A	TRANE	TPEFYP024MA144A	24,000	27,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-19	CU-3	CLASSROOM 3A	TRANE	TPEFYP024MA144A	24,000	27,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-20	CU-3	CLASSROOM 4A	TRANE	TPEFYP024MA144A	24,000	27,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-21	CU-3	CLASSROOM 5A	TRANE	TPEFYP024MA144A	24,000	27,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-22	CU-4	CLASSROOM 6A	TRANE	TPEFYP015MA144A	15,000	17,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-23	CU-4	CLASSROOM 7	TRANE	TPEFYP015MA144A	15,000	17,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-24	CU-4	CLASSROOM 8A	TRANE	TPEFYP015MA144A	15,000	17,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-25	CU-4	CLASSROOM 9A	TRANE	TPEFYP015MA144A	15,000	17,000	75.0	62.5	70.0	208	1	60	2.88	15	SEE NOTES 1-4
HP-26	CU-4	CLASSROOM 10	TRANE	TPEFYP018MA144A	18,000	20,000	75.0	62.5	70.0	208	1	60	2.94	15	SEE NOTES 1-4
HP-27	CU-4	MEAL PREP	TRANE	TPEFYP018MA144A	18,000	20,000	75.0	62.5	70.0	208	1	60	2.94	15	SEE NOTES 1-4
HP-28	CU-2	CORRIDOR 33	TRANE	TPLFYP015FM140A	15,000	17,000	75.0	62.5	70.0	208	1	60	0.35	15	SEE NOTES 1-4
HP-29	CU-2	CORRIDOR 33	TRANE	TPLFYP015FM140A	15,000	17,000	75.0	62.5	70.0	208	1	60	0.35	15	SEE NOTES 1-4
HP-30	CU-3	CORRIDOR 3	TRANE	TPLFYP012FM140A	12,000	13,500	75.0	62.5	70.0	208	1	60	0.35	15	SEE NOTES 1-4
HP-31	CU-2	LOUNGE	TRANE	TPKFYP012LM140A	12,000	13,500	75.0	62.5	70.0	208	1	60	0.35	15	SEE NOTES 1-4

NOTES:
1. PROVIDE CONDENSATE PUMPS FOR ALL UNITS. (CEILING CASSETTE'S AND DUCTED UNITS HAVE INTEGRAL CONDENSATE PUMPS)
2. VRF City-Multi Standard Warranty is 1 year parts, 7 year compressor from the time of startup. VRF City-Multi Extended 10-Year Parts/Compressor Warranty will be applied if the following requirements are met:Installing Contractor completes a certified Trane-Mitsubishi 3-day City-Multi Installation/Service Course, and documents attendees and date of completion. The system is designed by a certified Diamond Designer using Diamond System Builder™ The contractor generates a complete and approved METUS Extended Warranty Process Report from the Diamond System Builder software.(See Trane-Mitsubishi Warranty Policy for details.)
3. PROVIDE CN-24REALY kits for existing hot water radiation control integration.
4. PROVIDE MA CONTROLLER Model TAR-41MAAU
5. SUBMITTAL PACKAGE SHALL INCLUDE A COMPLETE CONTROL DIAGRAM, LIST OF FACTORY HARD-WIRED POINTS, LIST OF INSTALLED BACNET POINTS AND ANY CONTROL REQUIRED BY A 3RD PARTY BMS SYSTEM TO ACCOMMODATE ALL CONTROL SEQUENCES ON CONTRACT DOCUMENTS.

VANZELM ENGINEERS
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CONSULTANTS:

PROJECT NAME:
Juliet W. Long School
1854 Route 12
Gales Ferry, CT 06335

KEYPLAN

REVISIONS

REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:
MECHANICAL SCHEDULES

DRAWING NUMBER:
M500

DATE: 08/05/24
DRAWN BY: JDP/SPM
CHECKED BY: RSM
SCALE: N.T.S.
PROJ #: 2024087.00

File Name: Juliet Long Mechanical.dwg 8/5/2024
File Path: \\vz14\projects\2024\2024087.00\BIM\CAD\Mechanical 3:38:43 PM User ID: McKenna, Sean P

GENERAL ELECTRICAL DEMOLITION NOTES

A. REMOVE ALL EXISTING ELECTRICAL EQUIPMENT WITHIN DESIGNATED AREA, EXCEPT WHERE MARKED OTHERWISE, i.e. LIGHTING, SWITCHES, OUTLETS, PANELBOARDS, ASSOCIATED WIRING BACK TO SOURCE OR TO LAST ACTIVE DEVICE, CONDUIT, ETC. IN PREPARATION FOR NEW WORK. THIS WORK INCLUDES COMPLETE DEMO AND IS NOT LIMITED TO THE EQUIPMENT SHOWN ON DEMO PLANS.

B. REMOVE ALL EXISTING LOW VOLTAGE SYSTEMS AND EQUIPMENT WITHIN DESIGNATED AREA, INCLUDING BUT NOT LIMITED TO, TELEPHONE, DATA, TV, A/V, P.A., CLOCK AND SECURITY SYSTEMS (INCLUDING OUTLETS, ETC. AND ASSOCIATED WIRING) BACK TO SOURCE OR TO LAST ACTIVE DEVICE.

C. REMOVE EXISTING FIRE ALARM SYSTEM IN AREA DESIGNATED INCLUDING BUT NOT LIMITED TO, FIRE ALARM DEVICES, WIRING, CONDUIT, BOXES, PANELS, ETC. COORDINATE REMOVAL WORK WITH INSTALLATION OF NEW FIRE ALARM SYSTEM SUCH THAT AN OPERATIONAL FIRE ALARM SYSTEM IS MAINTAINED THROUGHOUT PERIODS OF BUILDING OCCUPATION. COORDINATE ANY SERVICE SHUT-DOWN WITH LOCAL FIRE OFFICIAL AND OWNER. PROVIDE FIRE WATCH AS REQUIRED.

D. DISCONNECT AND REMOVE EXISTING WIRING, CONDUIT, BOXES, ETC. SERVING ALL EQUIPMENT BEING REMOVED BY MECHANICAL AND OTHER TRADES. REFER TO PLUMBING, MECHANICAL AND ARCHITECTURAL DRAWINGS FOR COORDINATION OF REQUIRED WORK. REMOVALS SHALL BE BACK TO SOURCE PANEL COMPLETE.

E. EXISTING ELECTRICAL ITEMS THAT ARE BEING DISCONNECTED AND REMOVED AND NOT BEING REUSED SHALL BE DISPOSED OF PROPERLY.

F. ALL ABANDONED ELECTRICAL WIRING AND DEVICES SHALL BE REMOVED.

G. IF CONTINUITY OF WIRING TO EXISTING ELECTRICAL ITEMS IS INTERRUPTED BY REMOVAL OF DEVICES, CONTRACTOR SHALL INSTALL ALL NECESSARY WIRING AND RACEWAY TO ENSURE THE CONTINUITY OF CIRCUITRY IN OTHER AREAS.

H. WIRING FOR ITEMS BEING REMOVED SHALL BE REMOVED BACK TO POWER SOURCE OR LAST DEVICE TO REMAIN ACTIVE UNLESS NOTED OTHERWISE.

I. NOTIFY CONSTRUCTION MANAGER OR GENERAL CONTRACTOR OF OPENINGS CAUSED BY REMOVAL OF EXISTING EQUIPMENT NOT BEING REPLACED. ENSURE THE PATCHING IS COMPLETE.

J. REFER TO ARCHITECTURAL DRAWINGS FOR ADDITIONAL RELATED WORK.

K. ALL EXISTING EXPOSED RACEWAY THAT IS SERVING DEVICES IN FINISHED AREAS THAT ARE TO REMAIN SHALL BE REMOVED AND REPLACED WITH NEW CONCEALED CONDUIT/RACEWAY AND CONDUCTORS TO SERVE DEVICES.

L. INSTALL BLANK COVER PLATES ON RECESSED OUTLET BOXES ABANDONED UNDER THIS CONTRACT IN WALLS THAT ARE TO REMAIN.

M. WHERE POWER AND TEL/DATA OUTLETS EXIST ON WALLS TO BE FURRED OUT, THE ELECTRICAL CONTRACTOR SHALL REMOVE AND REINSTALL DEVICES AND PLATES AND PROVIDE BOX EXTENSIONS AS NECESSARY TO EXTEND THE OUTLETS TO THE NEW SURFACES.

N. REMOVE DEVICE PLATES (AND DEVICES WHERE NECESSARY) TO ACCOMMODATE NEW WALL FINISHES. REINSTALL COVER PLATES AND DEVICES AFTER NEW FINISHES ARE COMPLETE.

O. THE BUILDING WILL BE OCCUPIED DURING DEMOLITION. COORDINATE PHASING OF DEMO WORK WITH CONSTRUCTION MANAGER OR GENERAL CONTRACTOR. EXISTING PANELS MAY NEED TEMPORARY RE- FEED. ENSURE CONTINUITY OF SERVICES.

181102

GENERAL ELECTRICAL NOTES

A. ALL HOMERUNS/CIRCUITS TO BE 2#12, 1#12G,, 3/4"C TO A 20A-1P CIRCUIT BREAKER IN DESIGNATED PANEL, UNLESS NOTED OTHERWISE. NUMBERS SHOWN AT EACH DEVICE/HOMERUN REPRESENT CIRCUIT NUMBER IN PANELBOARD.

B. WIRE AND RACEWAY SIZES INDICATED ON HOMERUNS/CIRCUITS SHALL BE CONTINUOUS FOR ENTIRE LENGTH, UNLESS NOTED OTHERWISE.

C. ALL WIRING (CONDUITS, ETC.) TO BE CONCEALED. NO SURFACE WIRING SHALL BE INSTALLED IN FINISHED AREAS. THIS CONTRACTOR IS RESPONSIBLE FOR COORDINATING ALL CHANNELING REQUIRED OF EXISTING WALLS AND FLOORS TO ACCOMMODATE NEW WIRING. SEE PATCHING SPECIFICATIONS, FLOOR PLANS AND ELEVATIONS FOR ADDITIONAL INFORMATION ON ARCHITECTURAL AND WIRING ROUTING.

D. ALL WIRING ABOVE CEILING THAT IS NOT IN CONDUIT AND IS LOCATED IN A PLENUM SPACE SHALL BE PLENUM RATED. REFER TO MECHANICAL PLANS FOR PLENUM AREAS.

E. ELECTRICAL CONDUITS, WIRING, BOXES, ETC. SHALL NOT PENETRATE STAIR ENCLOSURE, UNLESS THEY ARE FEEDING DEVICES LOCATED WITHIN THE STAIR ENCLOSURE.

F. PROVIDE ELECTRICAL OUTLET PLATE GASKET SEALS AT RECEPTACLES, SWITCHES AND OTHER ELECTRICAL BOXES ON EXTERIOR WALLS AND INTERIOR WALLS BETWEEN CONDITIONED AND NON-CONDITIONED SPACES.

G. ALL INDIVIDUAL OR GENERAL PURPOSE BRANCH 120 VOLT CIRCUITS OVER 100'-0" IN CONDUCTOR LENGTH SHALL BE INCREASED ONE WIRE SIZE (i.e. FROM #12AWG TO #10AWG) AND CIRCUITS OVER 170'-0" IN CONDUCTOR LENGTH SHALL BE INCREASED TWO WIRE SIZES (i.e. FROM #12AWG TO #8AWG) UNLESS NOTED OTHERWISE.

H. ALL INDIVIDUAL OR GENERAL PURPOSE BRANCH 277 VOLT CIRCUITS OVER 230'-0" IN CONDUCTOR LENGTH SHALL BE INCREASED ONE WIRE SIZE (i.e. FROM #12AWG TO #10AWG) AND CIRCUITS OVER 380'-0" IN CONDUCTOR LENGTH SHALL BE INCREASED TWO WIRE SIZES (i.e. FROM #12AWG TO #8AWG.) UNLESS NOTED OTHERWISE.

I. SEAL ALL CONDUITS AT THE LAST STRUCTURE PRIOR TO CONDUITS ENTERING A BUILDING PER SPECIFICATIONS AND DETAILS. ALL SPARE CONDUITS SHALL HAVE NYLON PULL STRING AND FOOTAGE TAPE.

J. RACEWAY AND WIRING INDICATED ON DRAWINGS ARE RECOMMENDATIONS FOR SPECIFIC ROUTES OR SPECIAL CONDITIONS. CONTRACTOR IS RESPONSIBLE FOR DETERMINING ACTUAL ROUTING.

K. ALTHOUGH ALL FEEDER AND BRANCH CIRCUIT WIRE AND CONDUIT IS NOT SPECIFICALLY SHOWN, IT IS THE INTENT OF THESE DOCUMENTS THAT A COMPLETE FEEDER AND BRANCH CIRCUIT WIRING SYSTEM BE INSTALLED.

L. ENSURE THAT NO PIPING, DUCTWORK, LEAK PROTECTION APPARATUS OR OTHER EQUIPMENT FOREIGN TO THE ELECTRICAL TRADE PASSES THROUGH THE SPACE EQUAL TO THE WIDTH AND DEPTH OF THE ELECTRICAL DISTRIBUTION EQUIPMENT AND EXTENDING FROM THE FLOOR TO THE STRUCTURAL CEILING.

M. IN COMPOUNDING ROOMS #WING 132 AND MNG 136, SEAL AND GASKET ALL WALL PENETRATIONS WITH SILICONE CAULKING TO BE AIR/WATER TIGHT INCLUDING LIGHT FIXTURES, WALL SWITCHES, RECEPTACLES, DATA OUTLETS, FIRE ALARM DEVICES, ETC.

181102

GENERAL LIGHTING NOTES

A. REFER TO ARCHITECTURAL REFLECTED CEILING PLAN DRAWINGS FOR FINAL LOCATION OF ALL CEILING MOUNTED LIGHT FIXTURES.

B. REFER TO ARCHITECTURAL ELEVATIONS AND DETAILS FOR FINAL LOCATION OF WALL MOUNTED LIGHTING FIXTURES AND TASK LIGHTING.

C. SWITCHING SHOWN ON PLANS DOES NOT SHOW SWITCH LEG/TRACER WIRE BETWEEN SWITCHES. PROVIDE ALL REQUIRED WIRING FOR SWITCHING OF LIGHTING.

D. CONNECT UNDER CABINET LIGHTING TO LOCAL NON-COMPUTER BRANCH RECEPTACLE CIRCUIT.

E. A SWITCH IN A SPACE SHALL CONTROL LIGHTING IN THAT SPACE UNLESS OTHERWISE INDICATED.

F. ALL EXIT SIGNS SHALL BE WIRED TO LINE SIDE OF THE LIFE SAFETY (EMERGENCY) LIGHT CIRCUIT SERVING THE SAME AREA FOR CONTINUOUS ILLUMINATION.

160202

GENERAL POWER NOTES

A. COORDINATE EXACT LOCATION OF ELECTRICAL DEVICES SUCH AS RECEPTACLES, SWITCHES, FIRE ALARM DEVICES, ETC. WITH ARCHITECTURAL PLANS, ELEVATIONS AND DETAILS PRIOR TO START OF WORK, REQUEST CLARIFICATIONS FROM ARCHITECT PRIOR TO INSTALLATION.

B. ANY RECEPTACLE LOCATED WITHIN 6'-0" OF EDGE OF SINK SHALL BE A GFI RECEPTACLE OR PROTECTED BY A GFI CIRCUIT BREAKER.

C. UNLESS OTHERWISE INDICATED, REFER TO MOTOR CIRCUIT SCHEDULE FOR ELECTRICAL REQUIREMENTS OF ALL MECHANICAL (HVAC, PLUMBING, FIRE PROTECTION, ETC.) EQUIPMENT. REFER TO DRAWINGS FOR EACH TRADE FOR EXACT LOCATION OF EQUIPMENT.

D. DO NOT INSTALL OUTLETS BACK TO BACK. PROVIDE MINIMUM 24 INCH HORIZONTAL SPACING IN FIRE RATED WALLS. MOUNT LOW VOLTAGE AND POWER OUTLETS IN DIFFERENT STUD WALL CAVITIES.

E. WHEN THE COMBINING OF CIRCUITS OR HOMERUNS IS PERMITTED ELSEWHERE IN THE CONTRACT DOCUMENTS, RACEWAYS SHALL BE LIMITED TO SIX CURRENT CARRYING CONDUCTORS (THREE PHASE AND THREE NEUTRALS) PLUS GROUNDING CONDUCTORS UNLESS OTHERWISE INDICATED. PROVIDE A DEDICATED NEUTRAL FOR EACH SINGLE PHASE CIRCUIT, UNLESS "OVERSIZED" NEUTRAL IS PROVIDED AS PART OF MANUFACTURED ASSEMBLY. IF MANUFACTURED ASSEMBLIES ARE PROVIDED WITH "OVERSIZED" NEUTRALS, PROVIDE MATCHING "OVERSIZED" NEUTRALS FROM SOURCE PANEL TO MANUFACTURED ASSEMBLY.

F. PROVIDE NYLON PULL STRING IN ALL EMPTY CONDUIT SYSTEMS FOR USE IN INSTALLING SYSTEM WIRING.

G. REFER TO TELECOMMUNICATION, SECURITY AND AUDIO/VISUAL DRAWINGS FOR EXACT LOCATION OF ALL TELECOMMUNICATION OUTLETS, SECURITY DEVICES, VIDEO OUTLETS, AMPLIFIERS, SPEAKERS, ETC. WITH ARCHITECTURAL PLANS. REQUIRED RACEWAY FOR THESE SYSTEMS FOR A COMPLETE INSTALLATION. SEE ELECTRICAL, TELECOMMUNICATION, SECURITY AND AUDIO/VISUAL SPECIFICATIONS AND DRAWINGS FOR ADDITIONAL REQUIREMENTS.

H. COORDINATE EXACT LOCATION OF JUNCTION BOX FOR EQUIPMENT WHICH IS FURNISHED BY OWNER OR OTHERS WITH EQUIPMENT SUPPLIER PRIOR TO CONSTRUCTION. PROVIDE WIRING FROM JUNCTION BOX TO EQUIPMENT CONNECTION AS REQUIRED.

I. WIRING INDICATED BY CIRCUIT NUMBER SYMBOL SHALL INCLUDE A NEUTRAL WHEN THE LOAD SERVED HAS PROVISIONS FOR, OR REQUIRES A NEUTRAL, TYPICALLY, ALL FEEDERS AND BRANCH CIRCUITS WILL REQUIRE A NEUTRAL, EXCEPT MOST MOTOR CIRCUITS.

160202

GENERAL FIRE ALARM NOTES - RENO

A. THE EXISTING BUILDING FIRE ALARM SYSTEM SHALL REMAIN IN PLACE AND ACTIVE FOR FULL SYSTEM COMPATIBILITY. ALL NEW FIRE ALARM DEVICES SHALL BE MANUFACTURED BY SAME MANUFACTURER AS THE EXISTING SYSTEM. THERE ARE NO SUBSTITUTIONS OF FIRE ALARM DEVICES.

B. EXISTING FIRE ALARM CONDUIT AND BOXES MAY BE REUSED IF THEY SUIT THE PURPOSE. EXISTING FIRE ALARM CONDUIT AND BOXES NOT REUSED FOR NEW WIRING AND DEVICES SHALL BE REMOVED.

C. SHUTDOWNS OF A PORTION OF THE BUILDING FIRE ALARM SYSTEM MAY BE REQUIRED TO REMOVE AND REINSTALL FIRE ALARM DEVICES. COORDINATE THE TIME AND DURATION OF ANY FIRE ALARM SYSTEM SHUTDOWNS WITH OWNER. UNDER NO CIRCUMSTANCES WILL ANY UNATTENDED AREAS BE LEFT WITHOUT FIRE ALARM SYSTEM PROTECTION.

D. FIRE ALARM SYSTEM WIRING SHALL BE IN ACCORDANCE WITH NEC ARTICLE 760, AND AS RECOMMENDED BY THE MANUFACTURER OF THE FIRE ALARM SYSTEM. ALL WIRES SHALL BE COLOR CODED. NUMBER AND SIZE OF CONDUCTORS SHALL BE AS RECOMMENDED BY THE FIRE ALARM SYSTEM MANUFACTURER, BUT NOT LESS THAN #18 AWG FOR INITIATING DEVICE CIRCUITS AND #14 AWG FOR NOTIFICATION DEVICE CIRCUITS.

E. FIRE ALARM WIRING SHALL BE RUN IN 3/4" EMT MINIMUM; CONDUIT FILL SHALL NOT EXCEED 40% FILL. NEW DEVICES SHALL BE SECURELY AFFIXED TO BUILDING SURFACES.

F. NEW JUNCTION BOXES, PULL BOXES AND OUTLET BOXES IN THE FIRE ALARM SYSTEM SHALL BE PAINTED RED AND SHALL BE IDENTIFIED WITH WHITE MARKINGS AS "FA" FOR JUNCTION BOXES. LETTERING SHALL BE A MINIMUM OF 3/4 INCH HIGH.

G. AS PART OF THE FIRE ALARM EQUIPMENT SUBMITTAL PACKAGE THE ELECTRICAL CONTRACTOR SHALL FURNISH BATTERY CALCULATIONS INDICATING ADDITIONAL BATTERY CAPACITY REQUIRED TO POWER ALL NEW FIRE ALARM SYSTEM DEVICES INCLUDED AS PART OF THIS PROJECT.

H. THE MODIFICATIONS TO THE FIRE ALARM SYSTEM DESCRIBED SHALL BE INSTALLED, TESTED AND DELIVERED TO THE OWNER IN FULLY OPERATIONAL AND FIRST-CLASS CONDITION BY AN AUTHORIZED MANUFACTURER'S FIRE ALARM SYSTEM AGENT ONLY. WORK ON THE FIRE ALARM SYSTEM SHALL INCLUDE ALL HARDWARE, RACEWAYS, INTERCONNECTING WIRING, SOFTWARE AND PROGRAMMING TO ACCOMPLISH THE REQUIREMENTS OF THIS CONTRACT. THE FIRE ALARM EQUIPMENT SUPPLIER SHALL HAVE A MINIMUM OF TEN (10) YEARS PREVIOUS EXPERIENCE WITH FACILITY OPERATIONS AND REQUIREMENTS.

I. REFER TO ELECTRICAL SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.

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SWITCHES

SYMBOL	DESCRIPTION
$	SINGLE-POLE SWITCH
$2	DOUBLE-POLE SWITCH
$3	3-WAY SWITCH
$D	SINGLE-POLE DIMMER SWITCH
$T	MANUAL STARTER WITH THERMAL OVERLOAD PROTECTION
OPS,F,U	CEILING MOUNTED OCCUPANCY SENSOR; SUB-LETTER INDICATES TYPE
PAK	POWER PACK FOR OCCUPANCY SENSOR
LMX	LIGHTING CIRCUIT MONITOR CONTROL MODULE
LMX	LIGHTING CIRCUIT TRANSFER CONTROL MODULE
WSP,F,U	WALL MOUNTED OCCUPANCY SENSOR; SUB-LETTER INDICATES TYPE

POWER DEVICES

SYMBOL	DESCRIPTION
	ELECTRICAL PANEL 208 / 120 VOLT
	FUSED DISCONNECT SWITCH
M	ELECTRIC MOTOR
VFD	VARIABLE FREQUENCY DRIVE
J	JUNCTION BOX

LEGEND NOTE

THESE LEGENDS AND ABBREVIATIONS DEFINE ITEMS INDICATED ON DRAWINGS. NOT ALL SYMBOLS OR ABBREVIATIONS DEFINED ARE NECESSARILY USED ON THIS PROJECT.

NORMAL LIGHTING

SYMBOL	DESCRIPTION (SUB-LETTER INDICATES FIXTURE TYPE)
	CEILING MOUNTED 2'x2' LIGHT FIXTURE
	SINGLE-FACED CEILING OR WALL MOUNTED, EXIT SIGN WITH CHEVRONS AS INDICATED ON PLANS

SPECIAL SYSTEMS

SYMBOL	DESCRIPTION
	COMBINATION DATA / TELEPHONE OUTLET WITH BACKBOX AND EMPTY CONDUIT STUBBED UP TO ABOVE FINISHED CEILING, INCLUDING DRAG LINE
	TELEPHONE OUTLET WITH BACKBOX AND EMPTY CONDUIT, STUBBED UP TO ABOVE ACCESSIBLE FINISHED CEILING, INCLUDING DRAG LINE
	DATA OUTLET WITH BACKBOX AND EMPTY CONDUIT STUBBED UP TO ABOVE FINISHED CEILING, INCLUDING DRAG LINE
x	DATA OUTLET WITH BACKBOX AND EMPTY CONDUIT STUBBED UP TO ABOVE FINISHED CEILING, INCLUDING DRAG LINE. SUBLETTER "x" INDICATES OUTLET TO BE MOUNTED 6" ABOVE COUNTER TOP OR AT 48" AFF
WA	CEILING MOUNTED DATA OUTLET WITH BACKBOX AND EMPTY CONDUIT STUBBED TO ACCESSIBLE CEILING, INCLUDING DRAG LINE (WA INDICATES WIRELESS POINT)
C	DATA OUTLET WITH BACKBOX AND EMPTY CONDUIT TO ACCESSIBLE CEILING, INCLUDING DRAG LINE. SUBLETTER "C" INDICATES CEILING MOUNTED
S	CEILING MOUNTED SOUND SYSTEM SPEAKER

RECEPTACLES

SYMBOL	DESCRIPTION
S	SUBLETTER "S" ADJACENT TO DEVICE INDICATES RECEPTACLE ON STANDBY SOURCE. RECEPTACLE AND COVER PLATE SHALL BE RED IN COLOR
	DUPLEX RECEPTACLE. COORDINATE LOCATION WITH ARCHITECT
x	DUPLEX RECEPTACLE; SUBLETTER "x" INDICATES RECEPTACLE TO BE MOUNTED 6" ABOVE COUNTER TOP OR 48" AFF
b	DUPLEX RECEPTACLE; SUBLETTER "b" INDICATES MOUNTED IN ARCHITECTURAL MILLWORK
	DUPLEX RECEPTACLE; CEILING MOUNTED
	DOUBLE DUPLEX RECEPTACLE. COORDINATE LOCATION WITH ARCHITECT
x	DOUBLE DUPLEX RECEPTACLE; SUBLETTER "x" INDICATES RECEPTACLE TO BE MOUNTED 6" ABOVE COUNTER TOP OR 48" AFF
b	DOUBLE DUPLEX RECEPTACLE; SUBLETTER "b" INDICATES MOUNTED IN ARCHITECTURAL MILLWORK
	DOUBLE DUPLEX RECEPTACLE; CEILING MOUNTED
	SINGLE RECEPTACLE. COORDINATE LOCATION WITH ARCHITECT
x	SINGLE RECEPTACLE; SUBLETTER "x" INDICATES RECEPTACLE TO BE MOUNTED 6" ABOVE COUNTER TOP OR 48" AFF
b	SINGLE RECEPTACLE; SUBLETTER "b" INDICATES MOUNTED IN ARCHITECTURAL MILLWORK
	SINGLE RECEPTACLE; CEILING MOUNTED
x	DUPLEX RECEPTACLE-ONE OUTLET SWITCHED
c	DUPLEX RECEPTACLE CONTROLLED BY AUTOMATIC DEVICE; PROVIDE ANNOTATION ENGRAVED ON RECEPTACLE BODY
	FLUSH FLOOR MOUNTED DUPLEX RECEPTACLE
	FLUSH FLOOR MOUNTED DOUBLE DUPLEX RECEPTACLE
	SPECIAL-PURPOSE OUTLET; AMPERAGE AND VOLTAGE AS INDICATED ON PLANS. CONTRACTOR TO VERIFY CONNECTION / NEMA CONFIGURATION REQUIREMENTS WITH EQUIPMENT BEING FURNISHED
CH	DUPLEX RECEPTACLE WITH USB CHARGER PORT
WP	DUPLEX RECEPTACLE WITH WEATHER-PROOF IN-USE HOUSING
TR	DUPLEX RECEPTACLE; SUB-LETTER "TR" INDICATES TAMPER RESISTANT
GFI	GROUND FAULT CIRCUIT INTERRUPTER-STYLE DUPLEX RECEPTACLE
AFI	ARC FAULT CIRCUIT INTERRUPTOR-STYLE DUPLEX RECEPTACLE
IG	ISOLATED GROUND DUPLEX RECEPTACLE
SS	SURGE SUPPRESSION STYLE DUPLEX RECEPTACLE
TV	DUPLEX RECEPTACLE FOR TELEVISION. COORDINATE MOUNTING HEIGHT AND LOCATION WITH ARCHITECTURAL ELEVATIONS
	WALL CLOCK

NORMAL LIGHTING

SYMBOL	DESCRIPTION (SUB-LETTER INDICATES FIXTURE TYPE)
	CEILING MOUNTED 2'x2' LIGHT FIXTURE
	SINGLE-FACED CEILING OR WALL MOUNTED, EXIT SIGN WITH CHEVRONS AS INDICATED ON PLANS

SECURITY / ACCESS CONTROL

SYMBOL	DESCRIPTION
CR	CARD READER / PROXIMITY READER

FIRE ALARM

SYMBOL	DESCRIPTION
	FIRE ALARM SMOKE DETECTOR
F	FIRE ALARM VISUAL INDICATING UNIT SUB-LETTER "F" INDICATES SPECIAL CANDELA RATING
FH	FIRE ALARM AUDIO / VISUAL INDICATING UNIT WITH SPEAKER. SUB-LETTER "H" INDICATES HORN
D	DUCT MOUNTED SMOKE DETECTOR
RA	REMOTE DUCT SMOKE DETECTOR TEST SWITCH / INDICATOR
AM	ADDRESSABLE INTERFACE MODULE
FACP	FIRE ALARM CONTROL PANEL
SD	SMOKE DAMPER OR FIRE / SMOKE DAMPER

ABBREVIATIONS

SYMBOL	DESCRIPTION
ER	EXISTING TO REMAIN
GFI / GFCI	GROUND FAULT INTERRUPTER
NE	NEW LOCATION OF EXISTING RELOCATED
NL	NIGHT LIGHT
NR	NEW TO REPLACE EXISTING
P	POLE (SPACE IN PANELBOARD)
RE	REMOVE EXISTING
RL	RELOCATE EXISTING
TYP	TYPICAL
UNV	UNIVERSAL
VAC	VOLTS AC
WM	SURFACE MOUNTED RACEWAY

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Connecticut | Massachusetts | North Carolina

CONSULTANTS:

PROJECT NAME:

Juliet W. Long School
1854 Route 12
Gales Ferry, CT 06335

KEYPLAN

N

REVISIONS

REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:

ELECTRICAL LEGENDS AND GENERAL NOTES

DATE: 08/05/24
DRAWN BY: RZP
CHECKED BY: RSM
SCALE: N.T.S.
PROJ #: 2024087.00

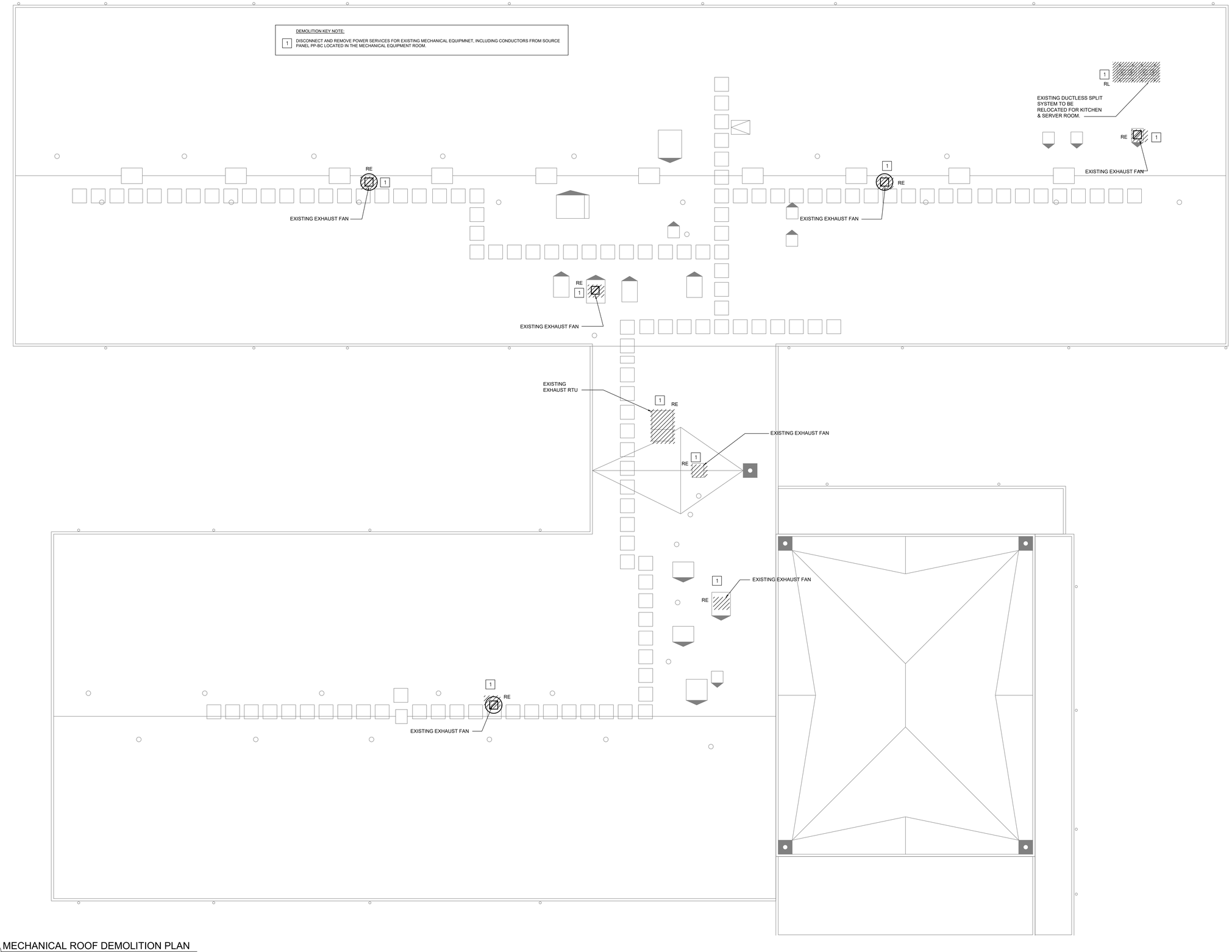
DRAWING NUMBER:

E000

File Name:E000_Legends.dwg 8/5/2024 3:38:47 PM User ID: McKenna, Sean P
File Path: \\vz14\projects\2024\2024087.00\BIM\CAD\Electrical

DEMOLITION KEY NOTE:

1 DISCONNECT AND REMOVE POWER SERVICES FOR EXISTING MECHANICAL EQUIPMNET, INCLUDING CONDUCTORS FROM SOURCE PANEL PP-BC LOCATED IN THE MECHANICAL EQUIPMENT ROOM.



1 MECHANICAL ROOF DEMOLITION PLAN
SCALE: 1/8"=1'-0"

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REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:
ELECTRICAL ROOF DEMOLITION PLAN

DATE: 08/05/24
DRAWN BY: RZP
CHECKED BY: RSM
SCALE: 1/8"=1'-0"
PROJ #: 2024087.00

DRAWING NUMBER:
ED101

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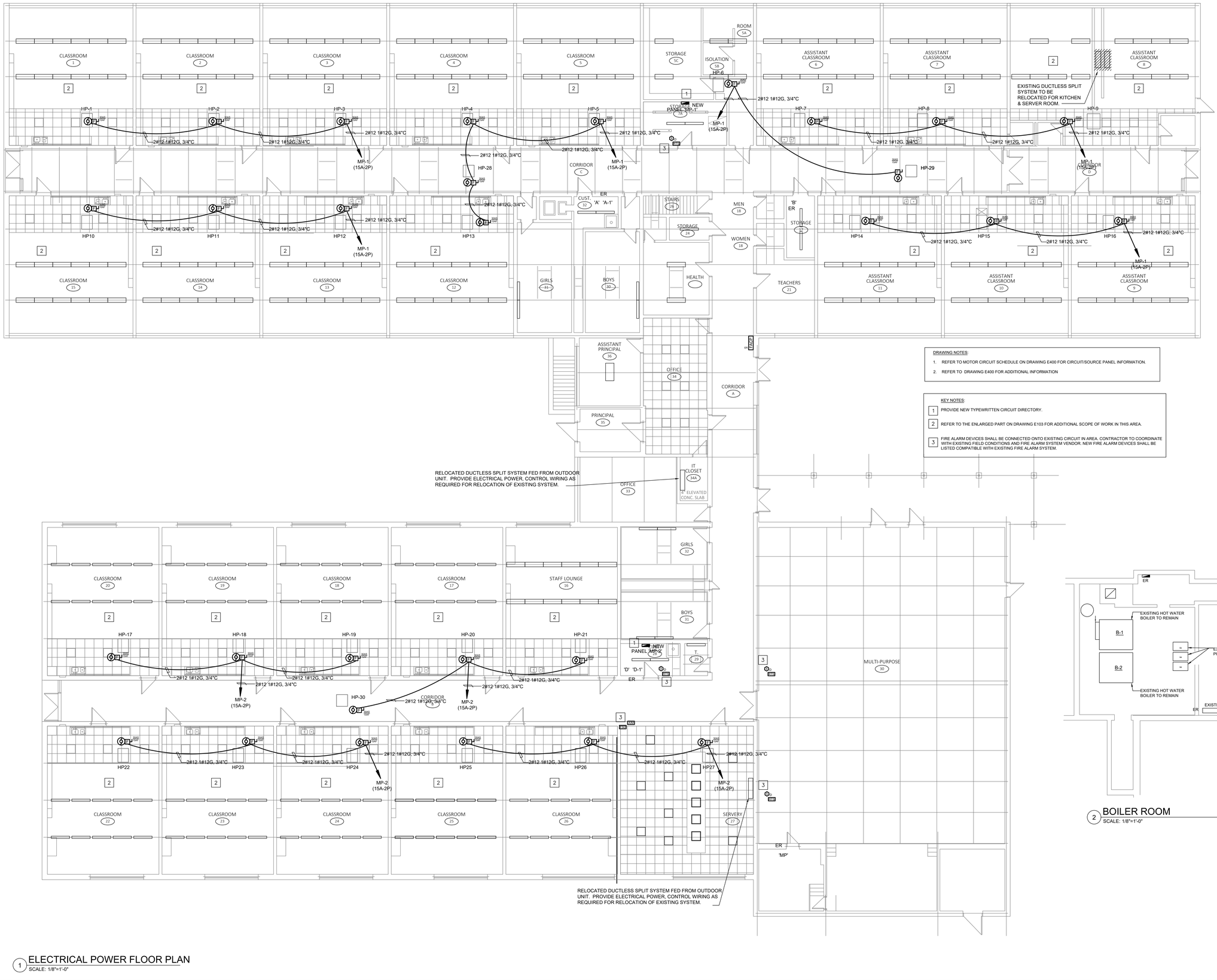

DRAWING NOTES:

1. REFER TO MOTOR CIRCUIT SCHEDULE ON DRAWING E400 FOR CIRCUIT/SOURCE PANEL INFORMATION.
2. REFER TO DRAWING E400 FOR ADDITIONAL INFORMATION

KEY NOTES:

1. PROVIDE NEW TYPEWRITTEN CIRCUIT DIRECTORY.
2. REFER TO THE ENLARGED PART ON DRAWING E103 FOR ADDITIONAL SCOPE OF WORK IN THIS AREA.
3. FIRE ALARM DEVICES SHALL BE CONNECTED ONTO EXISTING CIRCUIT IN AREA. CONTRACTOR TO COORDINATE WITH EXISTING FIELD CONDITIONS AND FIRE ALARM SYSTEM VENDOR. NEW FIRE ALARM DEVICES SHALL BE LISTED COMPATIBLE WITH EXISTING FIRE ALARM SYSTEM.

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

2 BOILER ROOM
SCALE: 1/8"=1'-0"

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REVISIONS

REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:
ELECTRICAL POWER FLOOR PLAN

DATE:	08/05/24
DRAWN BY:	RZP
CHECKED BY:	RSM
SCALE:	1/8"=1'-0"
PROJ #:	2024087.00

DRAWING NUMBER: EP101

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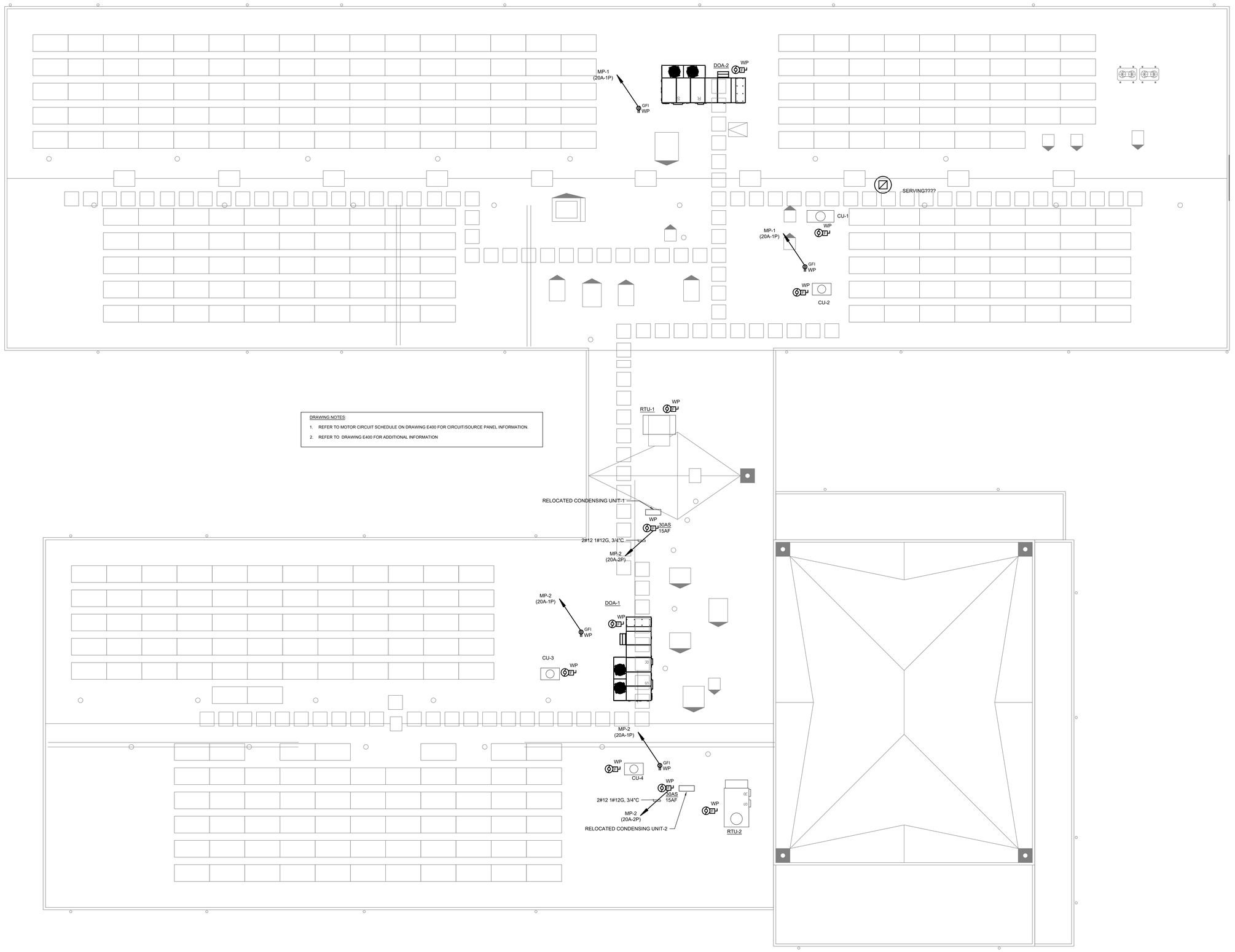

DRAWING NOTES:

1. REFER TO MOTOR CIRCUIT SCHEDULE ON DRAWING E400 FOR CIRCUIT/SOURCE PANEL INFORMATION.
2. REFER TO DRAWING E400 FOR ADDITIONAL INFORMATION

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REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:
ELECTRICAL ROOF
NEW WORK PLAN

DATE: 08/05/24
DRAWN BY: RZP
CHECKED BY: RSM
SCALE: 1/8"=1'-0"
PROJ #: 2024087.00

DRAWING NUMBER:
EP102

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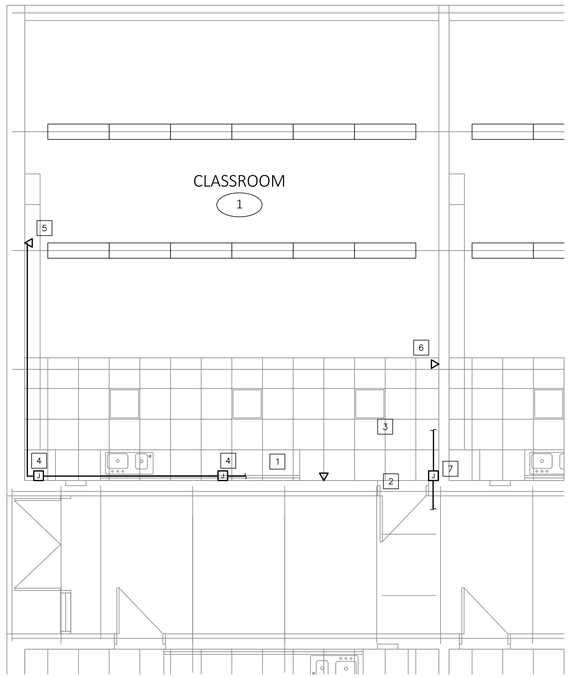
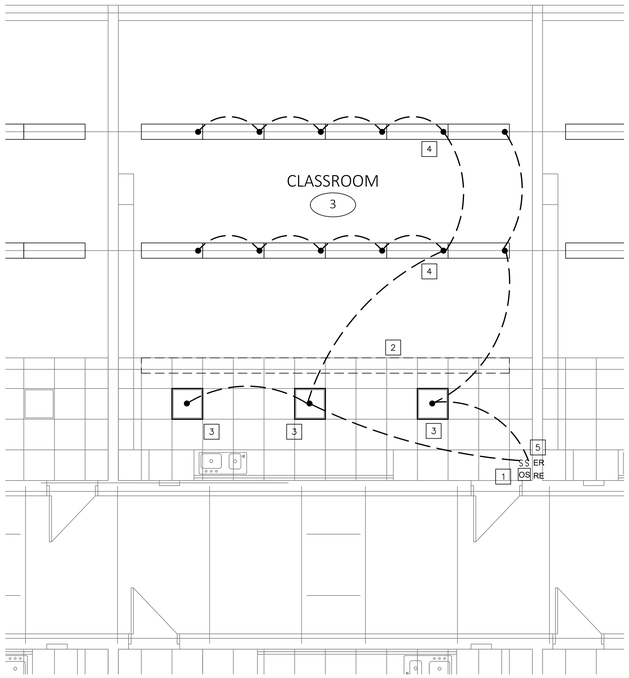


1 ELECTRICAL POWER PLAN
SCALE: 1/4" = 1'-0"

POWER PLAN-KEY NOTES:

1. RELOCATED EXISTING WALL-MOUNTED CLOCK . THE EXISTING WALL CLOCK SHALL BE MOUNTED ON THE SIDE OF THE NEW SOFFIT. EXTEND 120VAC CIRCUIT AS REQUIRED. COORDINATE WITH THE ARCHITECT AND OWNER'S REPRESENTATIVE ACTUAL LOCATION PRIOR TO INSTALLATION.
2. REMOVE EXISTING SPEAKER ON WALL. EXISTING WIRING TO REMAIN.
3. FURNISH AND INSTALL NEW CEILING MOUNT 25-VOLT SPEAKER, NEW SPEAKER SHOULD BE COMPATIBLE WITH THE EXISTING BOGEN CONTROL PANEL MODEL NUMBER MCP35A. EXTEND WIRING AS REQUIRED.
4. RELOCATE EXISTING JUNCTION BOX PART OF DATA RACEWAY. RE-ROUTED CONDUIT BELOW NEW DUCTWORK IN THE AREA WHERE A NEW CEILING IS INSTALLED.
5. EXISTING DATA DROP TO REMAIN. COORDINATE WITH THE OWNER'S REPRESENTATIVE IF THE DATA DROP WILL BE REMOVED IN SOME SPECIFIC CLASSROOM PRIOR TO RE-ROUTE THE CONDUIT IN THE AREA WHERE A NEW DROP CEILING IS INSTALLED.
6. SHIFT EXISTING DATA DROP TO THE LEFT TO CLEAR NEW CEILING. EXTEND CAT WIRE AS REQUIRED.
7. RELOCATE EXISTING JUNCTION BOX PART OF POWER WIRING.



1 ELECTRICAL LIGHTING PLAN
SCALE: 1/4" = 1'-0"

LIGHTING PLAN- KEY NOTES:

1. RELOCATE EXISTING WALL- MOUNTED OCCUPANCY SENSOR. MOUNT OCCUPANCY SENSOR AT 7' A.F.F. EXTEND CONTROL WIRING AS REQUIRED. REFER TO EACH ROOM FOR ACTUAL LOCATION.
2. REMOVE EXISTING LIGHT FIXTURES. EXISTING LED LIGHTS AT STEEL BEAM TO BE SALVAGED AND RETURNED TO OWNER FOR RE-USE.
3. FURNISH AND INSTALL NEW 2x2 LIGHT FIXTURE. COORDINATE LIGHT FIXTURE TYPE/SPECIFICATIONS WITH THE OWNER. EXTEND POWER AND CONTROL WIRING AS REQUIRED.
4. EXISTING LIGHT FIXTURES TO BE REMAIN.
5. EXISTING SINGLE POLE LIGHT SWITCHES TO BE REMAIN. COORDINATE LIGHTING CONTROL APPROACH WITH THE OWNER'S REPRESENTATIVE PRIOR TO INSTALLATION. REFER TO EACH ROOM FOR ACTUAL LOCATION.

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KEYPLAN

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REVISIONS

REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:
ELECTRICAL POWER AND LIGHTING ENLARGED CLASSROOM FLOOR PLAN TYPICAL

DATE: 08/05/24
DRAWN BY: RZP
CHECKED BY: RSM
SCALE: AS NOTED
PROJ #: 2024087.00

DRAWING NUMBER:
E103

ELECTRICAL MASTER STANPAT SPECIFICATION

ELECTRICAL SPECIFICATION

PART 1 - GENERAL

1.1 GENERAL

A. ARCHITECT'S GENERAL CONDITIONS ARE A PART OF THIS DIVISION. ALL WORK SHALL BE DONE IN STRICT ACCORDANCE WITH ALL APPLICABLE CODES AND REGULATIONS OF LOCAL AND STATE AGENCIES AND UTILITY COMPANIES. THIS CONTRACTOR SHALL BEAR THE COST OF ALL FEES, PERMITS, LICENSES AND TAXES AND ANY UTILITY COMPANY CHARGES IN CONNECTION WITH THE WORK. ALL EQUIPMENT INSTALLED SHALL BE UL LISTED.

B. AIA DOCUMENT A201-CURRENT VERSION, "GENERAL CONDITIONS OF THE CONTRACT FOR CONSTRUCTION" IS HEREBY MADE PART OF THESE SPECIFICATIONS.

C. THIS PROJECT WILL BE COMMISSIONED. REFER TO COMMISSIONING SPECIFICATION SECTIONS FOR COMMISSIONING INFORMATION AND RESPONSIBILITIES. THE COMMISSIONING PROCESS WILL REQUIRE ADDITIONAL LABOR, MATERIAL AND/OR OTHER COSTS WHICH MUST BE PROVIDED BY THE CONTRACTOR AS PART OF THIS PROJECT.

1.2 SCOPE

A. DEMOLITION:

1. THE CONTRACTOR SHALL REFERENCE ARCHITECTURAL AND ELECTRICAL PLANS AND REMOVE OR RELOCATE EXISTING ELECTRICAL MATERIALS AS SHOWN OR WHICH EXIST ON WALLS AND PARTITIONS BEING REMOVED. ADDITIONALLY, THE CONTRACTOR SHALL REMOVE ALL ELECTRICAL FEEDS TO EXISTING FURNITURE PARTITIONS TO BE REMOVED. REMOVAL OF WIRING THAT IS NO LONGER IN SERVICE SHALL BE COMPLETE BACK TO SOURCE. EXISTING CONDUIT MAY BE REUSED WHEN IN SUITABLE CONDITION. WIRING FOR BRANCH CIRCUITS SHALL NOT BE REUSED UNLESS OTHERWISE NOTED. CIRCUITS THAT REMAIN SHALL BE LEFT IN OPERATING CONDITION.
2. THE CONTRACTOR SHALL REMOVE ALL UNUSED TELEPHONE AND DATA CABLES COMPLETE FROM OUTLET TO PATCH PANEL.
3. EXISTING ELECTRICAL MATERIALS SHALL NOT BE REUSED UNLESS SO INDICATED ON THE DRAWINGS. EXISTING FLUSH-MOUNTED BOXES IN GOOD CONDITION MAY BE REUSED IF LOCATED AS SHOWN FOR NEW BOXES ON DRAWINGS. FLUSH-MOUNTED BOXES NOT BEING REUSED SHALL BE COVERED WITH SUITABLE COVER PLATES, SURFACE BOXES AND RACEWAYS SHALL BE REMOVED.
4. ALL MATERIALS REMOVED UNDER THIS DIVISION AND NOT SCHEDULED FOR REUSE OR REQUESTED BY THE OWNER, SHALL BE DISPOSED OF OFF SITE.

B. NEW WORK:

1. PROVIDE COMPLETE ELECTRICAL LIGHTING, POWER, FIRE ALARM AND SPECIAL SYSTEMS AS INDICATED ON THE CONTRACT DRAWINGS.
2. PROVIDE ALL ELECTRICAL WORK NECESSARY TO POWER OWNER-SUPPLIED EQUIPMENT. PROVIDE ALL RECEPTACLES, POWER WIRING, UNDERFLOOR DISTRIBUTION SYSTEM ACTIVATION FITTINGS, CORE DRILLS, ETC., NECESSARY FOR A COMPLETE INSTALLATION.
3. REFER TO ARCHITECTURAL SPECIFICATIONS FOR SECURITY SYSTEM REQUIREMENTS.
4. SYSTEMS SHALL BE COMPLETE IN ALL RESPECTS, TESTED, APPROVED AND READY FOR OPERATION.
5. MAINTAIN EXISTING RECEPTACLES ON EXISTING WALLS TO REMAIN, RECONNECT CIRCUITS THAT ARE INTERRUPTED.

C. WORK BY OTHERS:

1. OTHER TRADE CONTRACTORS AND OWNER'S EQUIPMENT VENDORS SHALL INSTALL ALL MOTORS FOR EQUIPMENT PROVIDED UNDER THEIR TRADE WORK CONTRACTS; MOTORS SHALL BE READY FOR WIRING BY THE ELECTRICAL CONTRACTOR.
2. OTHER TRADE CONTRACTORS AND OWNER'S EQUIPMENT VENDORS SHALL FURNISH AND DELIVER TO THE ELECTRICAL CONTRACTOR WIRING DIAGRAMS FOR ALL ELECTRICALLY OPERATED EQUIPMENT. OTHER TRADE CONTRACTORS SHALL FURNISH RELAYS AND CONTROL EQUIPMENT TO THE ELECTRICAL CONTRACTOR WHO SHALL INSTALL AND WIRE THESE DEVICES. THE ELECTRICAL CONTRACTOR SHALL PROVIDE MOTOR STARTERS AND DISCONNECT SWITCHES.
3. THE GENERAL CONTRACTOR SHALL PROVIDE EXCAVATION, BACKFILL, CHASES, OPENINGS, CUTTING, PATCHING, PAINTING AND FINISH WORK.
4. THE GENERAL CONTRACTOR SHALL INSTALL ALL ACCESS DOORS WHERE REQUIRED; DOORS NEEDED FOR ACCESS TO ELECTRICAL SYSTEMS SHALL BE FURNISHED BY THE ELECTRICAL CONTRACTOR.

1.3 SHOP DRAWING SUBMITTALS

A. SUBMIT SHOP DRAWINGS ON EQUIPMENT AND MATERIALS, IN SEXTUPLET (6 COPIES), TO THE ARCHITECT FOR APPROVAL. THE DRAWINGS SHALL INCLUDE RATINGS, PERFORMANCE INFORMATION, OPERATING DATA AND WIRING DIAGRAMS. THE CONTRACTOR SHALL ASSUME FULL RESPONSIBILITY FOR WORK PERFORMED OR EQUIPMENT SUPPLIED THAT IS NOT IN AGREEMENT WITH APPROVED SHOP DRAWINGS.

B. THE FOLLOWING LIST OF ELECTRICAL ITEMS MUST BE SUBMITTED BY THIS CONTRACTOR FOR APPROVAL:

1. CIRCUIT BREAKERS
2. WIRING DEVICES AND PLATES
3. FIRE ALARM SYSTEM COMPONENTS

C. SUBMIT FOR RECORD AN ITEMIZED LIST DETAILING ELECTRICAL SYSTEMS AND COMPONENTS TO BE SEISMICALLY RESTRAINED AND ASSOCIATED SEISMIC RESTRAINT SYSTEM TO BE USED.

1.4 RECORD DRAWINGS

A. NEATLY AND ACCURATELY RECORD ALL CHANGES TO CONTRACT DOCUMENTS ON RECORD SET OF DRAWINGS FURNISHED BY THE GENERAL CONTRACTOR. THESE RECORD "AS-BUILT" DRAWINGS SHALL INCLUDE LOCATIONS OF SPECIFIC ITEMS AS LISTED IN THE VARIOUS SPECIFICATION DIVISIONS. UPON PROJECT COMPLETION, THESE RECORD DRAWINGS SHALL BE TURNED OVER TO THE ENGINEER.

1.5 DEFINITION

A. AS USED ON CONTRACT DRAWINGS, THE TERM "TO PROVIDE" SHALL MEAN "TO FURNISH, INSTALL AND CONNECT COMPLETELY IN THE SPECIFIED OR APPROVED MANNER THE ITEM OR MATERIAL DESCRIBED."

1.6 GUARANTEE

A. MATERIALS, EQUIPMENT AND WORKMANSHIP SHALL HAVE STANDARD WARRANTY AGAINST DEFECTS IN MATERIAL AND WORKMANSHIP. FAILURES DUE TO DEFECTIVE OR IMPROPER MATERIAL, EQUIPMENT, WORKMANSHIP OR DESIGN SHALL BE MADE GOOD, FORTHWITH, BY AND AT THE EXPENSE OF THE CONTRACTOR, INCLUDING DAMAGE DONE TO AREAS, MATERIALS AND OTHER SYSTEMS RESULTING FROM SUCH FAILURES. GUARANTEE PERIOD SHALL EXTEND FOR ONE YEAR FROM THE DATE OF ACCEPTANCE.

1.7 INSPECTION

A. CONTRACT DRAWINGS ARE DIAGRAMMATIC AND DO NOT SHOW EVERY REQUIRED FITTING, ETC. THE CONTRACTOR SHALL FAMILIARIZE HIMSELF WITH EXISTING SITE CONDITIONS PRIOR TO SUBMITTING A BID, AND SHALL INCLUDE ALL EQUIPMENT AND ACCESSORIES NECESSARY FOR COMPLETE AND OPERATIONAL SYSTEMS.

1.8 INSURANCE

A. FURNISH INSURANCE CERTIFICATES REQUIRED BY THE OWNER.

1.9 PERMITS, LAWS, ORDINANCES, CODES AND STANDARDS

A. OBTAIN AND PAY FOR PERMITS, INSPECTIONS, LICENSES AND CERTIFICATES REQUIRED. WORK OF THIS CONTRACT SHALL MEET CURRENT ACCEPTED EDITIONS OF THE STATE BUILDING CODE, STATE FIRE SAFETY CODE AND OTHER LAWS, RULES AND REGULATIONS OF LOCAL, STATE AND FEDERAL AUTHORITIES INCLUDING, BUT NOT LIMITED TO: NATIONAL FIRE PROTECTION ASSOCIATION #13; NATIONAL FIRE PROTECTION ASSOCIATION #90A; NATIONAL FIRE PROTECTION ASSOCIATION #90B; NATIONAL FIRE PROTECTION ASSOCIATION #99; INTERNATIONAL PLUMBING CODE; INTERNATIONAL MECHANICAL CODE; NATIONAL FIRE PROTECTION ASSOCIATION #70 (NATIONAL ELECTRICAL CODE); AND LOCAL UTILITY COMPANY REQUIREMENTS. PAY UTILITY COMPANY BACKCHARGES. EQUIPMENT, MATERIALS AND COMPONENTS LISTED IN UL PRODUCT DIRECTORIES, SHALL BEAR UL LABELS.

1.10 ARRANGEMENT OF WORK

A. WORK SHALL BE COORDINATED BETWEEN TRADES TO PREVENT INTERFERENCE. WORK SHALL PRESENT A NEAT COORDINATED APPEARANCE. INSTALL WORK AS NECESSARY TO PROVIDE MAXIMUM POSSIBLE HEADROOM, ADEQUATE CLEARANCE AND READY ACCESS FOR INSPECTION, OPERATION, SAFE MAINTENANCE AND REPAIR AND CODE CONFORMANCE. WHERE SPACE APPEARS INADEQUATE, CONSULT THE ARCHITECT BEFORE PROCEEDING WITH INSTALLATION.

1.11 WORKMANSHIP

A. EQUIPMENT AND MATERIALS SHALL BE NEW, OF FIRST QUALITY, SELECTED AND ARRANGED TO FIT PROPERLY INTO SPACES INDICATED. INSTALL EQUIPMENT AND MATERIALS IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.

1.12 COORDINATION WITH OWNER

A. WORK SHALL BE SCHEDULED WITH THE OWNER. INTERRUPTIONS IN OWNER'S ACCESS TO THE SITE SHALL BE SUBJECT TO OWNER LIMITATIONS OF DATE AND DURATION.

1.13 OPERATION OF SERVICES AND UTILITIES

A. SHUTDOWN OF EXISTING SERVICES AND UTILITIES SHALL, WITHOUT EXCEPTION, BE COORDINATED WITH THE PROPER UTILITY AND WITH THE OWNER AS TO DATE, TIME OF DAY, AND DURATION BEFORE ANY SERVICE IS INTERRUPTED. NOTIFY THE OWNER OF ESTIMATED DURATION OF SHUTDOWN PERIOD AT LEAST TEN DAYS IN ADVANCE OF PROPOSED SHUTDOWN.

1.14 PROTECTION

A. CLOSE OPEN ENDS OF WORK WITH TEMPORARY COVERS OR PLUGS DURING CONSTRUCTION TO PREVENT ENTRY OF FOREIGN MATERIAL. PROTECT EXISTING PROPERTY, EQUIPMENT AND FINISHES FROM DAMAGE. REPAIR, TO ORIGINAL CONDITION, EXISTING PROPERTY THAT HAS BEEN DAMAGED DURING EXECUTION OF THE WORK.

B. TEMPORARY HEATING: APPLY TEMPORARY HEAT TO ELECTRICAL EQUIPMENT INCLUDING BUT NOT LIMITED TO SWITCHGEAR, SWITCHBOARDS, TRANSFORMERS AND MOTOR CONTROL CENTERS ACCORDING TO MANUFACTURER'S WRITTEN INSTRUCTIONS, THROUGHOUT PERIODS WHEN ENVIRONMENT IS NOT CONTROLLED FOR TEMPERATURE AND HUMIDITY WITHIN MANUFACTURER'S STIPULATED SERVICE CONDITIONS.

1.15 CLEANING

A. WORK SITE MUST BE KEPT CLEAN. RUBBISH, DEBRIS AND LEFTOVER OR EXCESS MATERIALS SHALL BE REMOVED DAILY.

1.16 LUBRICATION

A. NO EQUIPMENT SHALL BE OPERATED FOR TEMPORARY SERVICE OR TESTING WITHOUT PROPER LUBRICATION. ITEMS REQUIRING LUBRICATION SHALL BE LEFT FRESHLY AND FULLY LUBRICATED AT TIME OF SUBSTANTIAL COMPLETION. FURNISH OWNER WITH ONE COMPLETE NEW SET OF ANY SPECIAL LUBRICATION DEVICES REQUIRED FOR SERVICING, E.G., GREASE GUNS, FITTINGS AND ADAPTERS.

1.17 PAINTING

A. EQUIPMENT AND MATERIALS SHALL HAVE STANDARD MANUFACTURER'S FINISH EXCEPT WHERE OTHERWISE NOTED.

1.18 CUTTING AND PATCHING

A. CUTTING AND PATCHING TO BE PERFORMED BY (GENERAL CONTRACTOR) (THIS CONTRACTOR). PAINTING OF FINISHED SURFACES AFTER PATCHING SHALL BE AS SPECIFIED BY ARCHITECT OR SHALL MATCH ADJACENT FINISHES.

1.19 WATERPROOFING

A. PROVIDE NECESSARY SLEEVES, CAULKING AND FLASHING REQUIRED TO MAKE OPENINGS WATERPROOF.

1.20 FIREPROOFING

A. AT CLOSING OF EACH WORKING DAY, OPENING CUT BETWEEN FLOORS AND THROUGH FIRE-RATED PARTITIONS SHALL BE PROVIDED WITH UL APPROVED, CLASS A "NONCOMBUSTIBLE", FIRESTOPPING WITH RATINGS EQUAL TO THAT OF ADJACENT CONSTRUCTION.

1.21 BASES AND SUPPORTS

A. PROVIDE NECESSARY SUPPORTS, PADS, BASES AND PIERS FOR EQUIPMENT. EQUIPMENT SHALL BE SECURELY ATTACHED TO BUILDING STRUCTURE IN ACCEPTABLE MANNER. ATTACHMENTS SHALL BE OF STRONG AND DURABLE NATURE, AS DETERMINED BY THE OWNER.

1.22 ACCESS

A. PROVIDE ADEQUATELY SIZED ACCESS DOORS, FOR ACCESS TO CONCEALED EQUIPMENT AND COMPONENTS REQUIRING SERVICING OR INSPECTION. DOORS SHALL HAVE FIRE RATINGS EQUAL TO CONSTRUCTION IN WHICH THEY ARE LOCATED.

1.23 TESTS

A. PERFORM TESTS REQUIRED BY THE OWNER, LEGAL AUTHORITIES AND AGENCIES. EACH PIECE OF EQUIPMENT, INCLUDING MOTORS AND CONTROLS, SHALL BE OPERATED CONTINUOUSLY FOR MINIMUM ONE-HOUR TEST. CORRECT ALL DEFECTS APPEARING DURING TESTS, AND REPEAT TESTS UNTIL NO DEFECTS ARE DISCLOSED. FINAL TESTS SHALL BE MADE IN THE OWNER'S PRESENCE.

1.24 SYSTEMS OPERATION AND MAINTENANCE

A. UPON COMPLETION OF THE WORK AND AT A TIME DESIGNATED BY THE ENGINEER, THE CONTRACTOR SHALL FURNISH INSTRUCTION MANUALS INCLUDING DATA, WARRANTIES, ETC., AND SHALL INSTRUCT THE OWNER OR HIS REPRESENTATIVE AS TO THE ARRANGEMENT, LOCATION AND OPERATION OF ALL EQUIPMENT AND SYSTEMS FURNISHED AND INSTALLED UNDER THE ELECTRICAL CONTRACT.

1.25 SEISMIC REQUIREMENTS

A. SUBMIT SIX (6) COPIES OF A FINAL INSPECTION REPORT WHICH INCLUDES: SEALED CERTIFICATION BY A STRUCTURAL ENGINEER WITH P.E. REGISTRATION IN THE STATE IN WHICH THE PROJECT IS LOCATED, THAT:

1. ENGINEER HAS REVIEWED THE PROJECT.
2. ENGINEER HAS APPROVED THE USE OF THE DEVICES FOR THE PARTICULAR APPLICATIONS.
3. THE DEVICES SATISFY SPECIFICATION- AND CODE-MANDATED SEISMIC CRITERIA.

B. APPLICATION OF SEISMIC RESTRAINT REQUIREMENTS IS GOVERNED BY THE 2005 STATE OF CONNECTICUT BUILDING CODE WITH REFERENCE TO A.S.C.E. 7-05, SECTION 9.6. REFER TO ARCHITECTS CODE SHEET FOR THE SEISMIC DESIGN CATEGORY FOR THIS PROJECT.

C. SEISMIC RESTRAINT FOR ALL TRADES SHALL BE PROVIDED AS REQUIRED, BASED ON THE BUILDING SEISMIC DESIGN CATEGORY AND MATERIAL IMPORTANCE FACTORS. REFER TO INDIVIDUAL TRADE SECTIONS FOR ADDITIONAL REQUIREMENTS.

PART 2 - PRODUCTS

2.1 WIRE CABLE AND RACEWAYS

A. ELECTRICAL METALLIC TUBING (EMT) SHALL BE USED FOR FEEDERS RUN ABOVE GROUND IN DRY AREAS. CONNECTORS AND COUPLINGS SHALL BE GALVANIZED STEEL, EITHER COMPRESSION TYPE OR HEAVY-DUTY SET SCREW-TYPE, LISTED FOR EMT USE. INDENT OR CRIMP-TYPE CONNECTORS ARE NOT ALLOWED.

B. EMT OR RGS SHALL BE USED FOR ALL CIRCUIT HOMERUNS.

C. MINIMUM SIZES SHALL BE AS FOLLOWS:

1. CONDUIT AND EMT: 3/4" UNLESS OTHERWISE NOTED.
2. FLEXIBLE METAL CONDUIT: ½"
3. WIREWAY: 4" X 4".

D. TYPE MC METAL-CLAD CABLE MAY BE USED FOR BRANCH WIRING TO LIGHT FIXTURES, RECEPTACLES AND SWITCHES. WHEREVER MC CABLE IS USED FOR LIGHT FIXTURE WIRING, LEAVE SUFFICIENT SLACK FOR FUTURE REMOVAL OR SERVICING OF FIXTURES IN FINISHED CEILINGS. THE MC CABLE SHALL BE UL LISTED, 600V, 90 DEGREE C RATED, METAL CLAD WITH THHN INSULATION AND GREEN INSULATED GROUND WIRE. CONNECTORS AND FITTINGS SHALL BE GALVANIZED STEEL, LISTED FOR MC CABLE USE. ALL CABLES SHALL BE RIGIDLY SUPPORTED FROM THE BUILDING STRUCTURE AT LEAST 4' O.C. AND WITHIN 12" FROM EVERY FITTING AND SHALL RUN IN LINES PARALLEL OR PERPENDICULAR TO BUILDING STRUCTURAL MEMBERS. CABLE SHALL NOT REST ON THE CEILING STRUCTURE. TYPE MC CABLE SHALL NOT BE USED FOR HOMERUNS. CABLE SHEATH OF INTERLOCKED ALUMINUM IS NOT ACCEPTABLE. TYPE AC ARMORED CABLE SHALL NOT BE PERMITTED ON THE JOB.

E. FLEXIBLE METALLIC CONDUIT (FMC) OR LIQUID-TIGHT FLEXIBLE METALLIC CONDUIT (LFMC) SHALL BE USED FOR CONNECTIONS TO VIBRATING EQUIPMENT AND FURNITURE PARTITIONS. CONNECTORS, FITTINGS AND CLAMPS FOR FMC SHALL BE GALVANIZED STEEL, LISTED FOR FMC USE. CONNECTORS AND COUPLINGS FOR LFMC SHALL BE ZINC PLATED MALLEABLE IRON OR STEEL, WITH ENGAGEMENT WINDOW LOCKNUT AND SEALING RING: LIQUID, OIL, AND RAIN-TIGHT; SUITABLE FOR WET LOCATIONS, LISTED FOR LFMC USE: ACCEPTABLE EQUIVALENT TO O-Z/GEDNEY "TYPE 4Q".

1. BLUE TYPE LA LIQUID-TIGHT FLEXIBLE METAL CONDUIT (LFMC) SHALL BE USED FOR ALL WIRING BENEATH RAISED FLOOR.
2. GREY/TAN TYPE LA LIQUID-TIGHT FLEXIBLE METAL CONDUIT (LFMC) SHALL BE USED FOR FINAL CONNECTIONS TO VIBRATING EQUIPMENT AND TO FURNITURE PARTITIONS FROM UNDERFLOOR DUCT ACTIVATION FITTINGS.

F. WIRING THAT MUST BE RUN ALONG THE SURFACE OF THE EXISTING WALLS SHALL BE RUN IN WIREMOLD #500 SURFACE METAL RACEWAY, WIREMOLD #2100 SURFACE METAL RACEWAY OR AS OTHERWISE SPECIFIED ON THE DRAWINGS.

G. CONDUCTORS SHALL BE NEW COPPER WITH 600 VOLT CODE GAUGE INSULATION CONFORMING TO NEC REQUIREMENTS. WIRE #10 AND SMALLER SHALL BE SOLID CONDUCTOR WITH THWN/THHN INSULATION, SIZE #8 AND LARGER SHALL BE STRANDED CONDUCTORS WITH THWN/THHN INSULATION. SIZE #3 AND LARGER SHALL BE STRANDED CONDUCTORS WITH XHHW INSULATION. MINIMUM SIZE WIRE FOR LIGHT AND POWER CIRCUITS SHALL BE #12 AWG. THE CONTRACTOR SHALL INCLUDE AN INDIVIDUAL CODE SIZED GREEN INSULATED GROUND CONDUCTOR FOR ALL CIRCUITS; THE USE OF THE CONDUIT SYSTEM OR CABLE COVERING AS THE SOLE MEANS OF GROUNDING WILL NOT BE PERMITTED.

H. COMMON NEUTRALS SHALL NOT BE USED FOR RECEPTACLE CIRCUITS, UNLESS OTHERWISE NOTED ON PLANS. WHEN USED, COMMON NEUTRAL CONDUCTOR AMPERE RATING SHALL BE DOUBLE THE PHASE CONDUCTOR RATING.

I. ALL CONDUITS AND WIRING SHALL BE RUN CONCEALED INSIDE WALLS WHERE POSSIBLE. EXPOSED CONDUITS WHERE ALLOWED SHALL BE RUN NEATLY IN LINES PARALLEL OR PERPENDICULAR TO BUILDING WALLS.

J. ALL SPLICES FOR #10 OR SMALLER SHALL BE MADE WITH "SCOTCHLOK" SPRING CONNECTORS OR EQUAL. SPLICES FOR #8 OR LARGER SHALL BE MADE WITH UL APPROVED COMPRESSION CONNECTORS.

K. PROVIDE NYLON PULL LINES FOR ALL EMPTY CONDUITS.

2.2 GROUNDING AND BONDING

A. EQUIPMENT GROUNDS

1. GROUNDING SHALL BE INSTALLED AND TESTED IN ACCORDANCE WITH NFPA 70 (NEC) AND TO SATISFACTION OF LOCAL ELECTRICAL INSPECTOR AND ARCHITECT.
2. PROVIDE GREEN THHN INSULATED COPPER EQUIPMENT GROUNDING CONDUCTOR BETWEEN THE GROUND BUS OF THE SOURCE DISTRIBUTION PANEL OR SWITCHBOARD AND EACH LOAD BEING SERVED. CONDUCTOR SHALL BE SIZED ACCORDING TO NEC TABLE 250.122. PROVIDE SEPARATE GROUNDING CONDUCTOR FOR EACH BRANCH CIRCUIT, UNLESS OTHERWISE INDICATED ON CONTRACT DRAWINGS.
3. MAINTAIN ELECTRICAL CONTINUITY OF RACEWAYS.

B. GROUND FAULT PROTECTION

1. IF EXCESSIVE GROUND CURRENT FLOWS, MAIN BREAKERS AND/OR CIRCUIT BREAKERS WITH GROUND FAULT SENSING SHALL TRIP TO PROTECT AGAINST ARCING GROUND FAULTS.
2. PROVIDE GROUND FAULT CIRCUIT INTERRUPTER PROTECTION FOR RECEPTACLES LOCATED WITHIN SIX FEET OF SINK OR FAUCET AND AS REQUIRED AND INDICATED.

C. MATERIALS

1. ABOVE-GRADE AND EXPOSED CONNECTIONS SHALL BE BURNDY OR ACCEPTABLE EQUIVALENT.
2. WIRE SHALL BE STRANDED BARE COPPER OR INSULATED COPPER, AS INDICATED ON CONTRACT DRAWINGS.
3. BUS SHALL BE COPPER BAR, AS INDICATED ON CONTRACT DRAWINGS.
4. BUSHINGS AND PRESSURE LUGS SHALL BE BY T&B, O.Z./GEDNEY OR ACCEPTABLE EQUIVALENT.
5. PIPE CLAMPS SHALL BE BY O.Z./GEDNEY OR ACCEPTABLE EQUIVALENT.

2.3 SAFETY SWITCHES

A. SAFETY SWITCHES SHALL BE FUSED, 600 VAC, HEAVY-DUTY TYPE IN NEMA ENCLOSURES SUITABLE FOR THE ENVIRONMENT IN WHICH THEY SHALL BE INSTALLED. SWITCHES SHALL BE SQUARE D, GENERAL ELECTRIC OR CUTLER-HAMMER EQUIVALENT TO THE FOLLOWING SQUARE D TYPES:

1. FUSED DISCONNECT 2- AND 3-POLE: "TYPE H"
2. FUSED, RAINTIGHT (WP) DISCONNECT SWITCHES IN NEMA 3R ENCLOSURES: "TYPE H-R".

2.4 FUSES

A. FUSES FOR CIRCUIT PROTECTION SHALL BE UL LISTED, NON-RENEWABLE, LOW PEAK, DUAL-ELEMENT, TIME DELAY FUSES. BUSSMAN TYPE FRN-RK (250 VOLT) OR FRS-RK (460 VOLT) UL CLASS RK5 OR APPROVED EQUAL.

2.5 OUTLET AND JUNCTION BOXES

A. SWITCH AND RECEPTACLE OUTLET BOXES IN PARTITIONS WHERE WIRING IS CONCEALED SHALL BE STANDARD 4 INCHES SQUARE, 1-1/2 INCHES DEEP, HOT-DIPPED, GALVANIZED STEEL, WITH DEVICE RING FOR BOXES INSTALLED IN SHEETROCK WALLS. USE 1-1/2 INCH DEEP SQUARE CORNER TILE WALL EXTENSION FOR BOXES INSTALLED IN TILE, EXPOSED BRICK OR EXPOSED BLOCK MASONRY WALLS.

B. BOXES SHALL BE SECURELY FASTENED TO THE BUILDING STRUCTURE. SUITABLE MEANS SHALL BE PROVIDED TO SUPPORT OUTLET BOXES TO TAKE THE WEIGHT OF FIXTURES. RECESSED OUTLET BOXES OR THEIR EXTENSION COVERS SHALL BE SET FLUSH WITH FACE OF FINISHED WALL, BUT IN NO CASE SET GREATER THAN 1/4 INCH BEHIND FINISHED FACE OF WALL. THE CONTRACTOR SHALL CHECK WITH THE ARCHITECTURAL DRAWINGS FOR POSSIBLE BOX INTERFERENCE.

C. JUNCTION BOXES SHALL BE SIZED IN ACCORDANCE WITH CODE REQUIREMENTS.

D. JUNCTION AND OUTLET BOXES WHERE EXPOSED TO THE WEATHER AND WET LOCATIONS SHALL BE THREADED HUB TYPE AND PROVIDED WITH WATERTIGHT SCREW-ON COVERS AND GASKETS.

2.6 SWITCHES, RECEPTACLES AND PLATES

A. SWITCHES AND RECEPTACLES SHALL BE AS MANUFACTURED BY HUBBELL, ARROW-HART, LEVITON OR PASS AND SEYMOUR AND EQUIVALENT TO THE FOLLOWING SPECIFICATION GRADES, WITH COLOR MATCHING BUILDING STANDARD:

1. SINGLE-POLE SWITCHES SHALL BE HUBBELL #1221.
2. 3-WAY SWITCHES SHALL BE HUBBELL #1223.
3. MOMENTARY CONTACT SWITCHES SHALL BE SINGLE-POLE, DOUBLE-THROW EQUIVALENT TO HUBBELL #1557.
4. DUPLEX GROUNDING TYPE RECEPTACLES SHALL BE 20 AMPERE HUBBELL #5362.
5. ISOLATED GROUND TYPE RECEPTACLES SHALL BE 20 AMPERE HUBBELL #IG5362.
6. GROUND FAULT TYPE RECEPTACLES SHALL BE HUBBELL #GFRSTS20.

B. PROVIDE WALL PLATES EQUAL TO BUILDING STANDARD ON ALL SWITCHES AND RECEPTACLES. WHEN NO STANDARD EXISTS PROVIDE SPECIFICATION GRADE STAINLESS STEEL (TYPE 302).

C. WHERE THERE ARE MULTIPLE DEVICES IN ONE LOCATION, DEVICES SHALL BE GANGED UNDER ONE COVER PLATE. ALL WALL SWITCHES SHALL BE FLUSH MOUNTED, WHERE APPLICABLE.

D. RECEPTACLES SHALL BE MOUNTED 18 INCHES ABOVE FINISHED FLOOR WITH U GROUND UP UNLESS OTHERWISE INDICATED.

E. WALL SWITCHES SHALL BE MOUNTED 48 INCHES ABOVE FINISHED FLOOR, ON STRIKE SIDE OF DOOR, UNLESS OTHERWISE INDICATED.

F. EXISTING FIXTURES IN THE SPACE SHALL BE REUSED WHERE NOTED ON THE DRAWINGS. THE FIXTURES SHALL BE DISCONNECTED, REMOVED AND STORED BY THE ELECTRICAL CONTRACTOR AND THEN BE CLEANED AND REPLACED PRIOR TO REINSTALLATION. THE ELECTRICAL CONTRACTOR SHALL DOCUMENT, IN WRITING, ANY DAMAGE NOTED ON THE FIXTURES PRIOR TO REMOVING THEM AND SUBMIT A COPY TO THE GENERAL CONTRACTOR AND THE ENGINEER. THE ELECTRICAL CONTRACTOR SHALL BE HELD RESPONSIBLE FOR DAMAGE CAUSED BY WORK UNDER THIS PROJECT.

G. FIXTURES NOT NOTED AS BEING REUSED WILL BE TURNED OVER TO THE BUILDING OWNER, OR DISPOSED OF PER THE OWNER'S DIRECTION DURING CONSTRUCTION.

H. INSTALLATION OF LIGHTING FIXTURES:

1. FIXTURES SHALL BE SECURELY ATTACHED TO THE BUILDING STRUCTURE BY MECHANICAL MEANS AND BY SAFETY WIRE. PROVIDE BOX-MOUNTED STUDS AND ADDITIONAL STRUCTURAL SUPPORTS AS REQUIRED. PROVIDE TWO SAFETY WIRES PER FIXTURE. EACH SAFETY WIRE SHALL BE CAPABLE OF SUPPORTING FOUR TIMES THE WEIGHT OF THE FIXTURE. SAFETY WIRE SHALL BE ADJUSTED TO BE IN SLACK TENSION.
2. INSTALL SEISMICALLY RATED CLIPS TO SECURE RECESSED GRID-SUPPORTED LUMINAIRES IN PLACE. PROVIDE FOUR CLIPS PER FIXTURE.

2.7 FIRE ALARM

A. FIRE ALARM COMPONENTS SHALL BE COMPATIBLE WITH EXISTING BUILDING SYSTEM. PROVIDE ADDITIONAL CARDS AS REQUIRED TO CONTROL ADDITIONAL INITIATION DEVICES. PROVIDE ADDITIONAL AMPLIFIERS, ETC. REQUIRED TO POWER ADDITIONAL DEVICES REQUIRED TO COMPLY WITH A.D.A. ALL DEVICES AND MOUNTING HEIGHTS SHALL CONFORM TO CURRENT A.D.A. STANDARDS. STROBE UNITS SHALL BE XENON STROBE TYPE.

1. COMBINATION FIRE SPEAKER/STROBE UNITS SHALL BE MULTI-TAP SPEAKER, INITIALLY SET APPROPRIATE TAP TO PROVIDE PROPER SOUND LEVELS AND SYNCHRONIZED VISUAL UNIT WITH APPROPRIATE MODULE ADAPTER MOUNTED ON COMMON MOUNTING PLATE.
2. SMOKE DETECTORS SHALL BE ADDRESSABLE, PHOTOELECTRIC OR IONIZATION TYPE WITH TWIST LOCK BASE.
3. DUCT SMOKE DETECTORS SHALL BE ADDRESSABLE, PHOTOELECTRIC TYPE, WITH TWIST LOCK BASE, HOUSING, SAMPLING TUBES AND RELAY OUTPUT WITH REMOTE LED INDICATOR/TEST SWITCH AND APPROPRIATE SAMPLING TUBES.
4. ADDRESSABLE INTERFACE MODULES SHALL BE PROVIDED FOR MONITORING OF NON-ADDRESSABLE DEVICES AND FOR CONTROL PURPOSES.
5. PROVIDE AND INSTALL ONE MONITOR MODULE PER SMOKE DAMPER - FIRE SYSTEM SHALL MONITOR STATUS OF LIMIT SWITCH MOUNTED ON SMOKE DAMPER.
6. CONTRACTOR SHALL INSTALL CABLE IN A CLASS A CONFIGURATION. THIS SHALL BE IN ACCORDANCE WITH MANUFACTURES INSTRUCTIONS AND SHALL INCLUDE A SPECIAL EVACUATION APPLIANCE CABLE SCHEME. ALL EVACUATION APPLIANCES SHALL BE CABLED IN AN ALTERNATING FASHION BACK TO SEPARATE AMPLIFIER / POWER SUPPLY CABINETS SO THAT FAILURE OF ONE CIRCUIT WILL NOT EFFECT OCCUPANT NOTIFICATION. THERE SHALL BE AT LEAST TWO SEPARATE AMPLIFIER / POWER SUPPLY CIRCUITS FOR THIS FLOOR.

B. INITIATING CIRCUIT WIRING SHALL BE TYPE FPLP CABLE, SINGLE PAIR, TWISTED SHIELDED, SOLID THHN WITH GROUND (DRAIN) WIRE, RUN IN EMT CONDUIT, WITH MAXIMUM 6' LENGTH OF FMC WHERE REQUIRED.

C. NOTIFICATION CIRCUIT WIRING SHALL BE TYPE FPLP CABLE, SINGLE PAIR, TWISTED SHIELDED, SOLID THHN WITH GROUND (DRAIN) WIRE, AND 2 #12, 1 #12G THHN, RUN IN EMT CONDUIT, WITH MAXIMUM 6' LENGTH OF FMC WHERE REQUIRED.

D. NOTIFICATION CIRCUIT WIRING FROM THE POINT IT LEAVES THE FIRE ALARM SYSTEM NODE AND/OR TRANSPONDER TO THE POINT THE CIRCUIT ENTERS THE NOTIFICATION ZONE IT SERVES SHALL BE TYPE MI CABLE, SINGLE PAIR, TWISTED SHIELDED, SOLID AND SEPARATE (2) #12 SOLID. CABLES SHALL BE BUNDLED TOGETHER WITH STAINLESS STEEL STRAPS 2'-0" O.C.

E. WIRING FOR NETWORKING CABLING BETWEEN FIRE ALARM SYSTEM NODES AND/OR TRANSPONDERS SHALL BE TYPE MI CABLE, EIGHT (8) RUNS OF SINGLE PAIR, TWISTED SHIELDED, SOLID. CABLES SHALL BE BUNDLED TOGETHER WITH STAINLESS STEEL STRAPS 2'-0" O.C.

2.8 CIRCUIT BREAKERS

A. ALL NEW CIRCUIT BREAKERS SHALL MATCH EXISTING IN STYLE, MANUFACTURER AND INTERRUPTING RATING FOR PANEL IN WHICH THEY ARE BEING INSTALLED, UNLESS NOTED OTHERWISE.

PART 3 - EXECUTION

3.1 GENERAL

A. THE ELECTRICAL CONTRACTOR SHALL ENSURE THAT NO PIPING, DUCTWORK, LEAK PROTECTION APPARATUS OR OTHER EQUIPMENT FOREIGN TO THE ELECTRICAL TRADE PASSES THROUGH THE SPACE EQUAL TO THE WIDTH AND DEPTH OF THE ELECTRICAL DISTRIBUTION EQUIPMENT AND EXTENDING FROM THE FLOOR TO THE STRUCTURAL CEILING.

3.2 LOAD BALANCE

A. THE ELECTRICAL CONTRACTOR SHALL BALANCE THE LOADS ON THE THREE PHASES IN THE ELECTRICAL PANELBOARD IN WHICH HE DOES WORK INSOFAR AS PHYSICALLY POSSIBLE, AND REPORT EACH PANEL LOADING TO THE ENGINEER.

3.3 CIRCUIT BREAKER TESTING/SETTING

A. FEEDER CIRCUIT BREAKERS SHALL BE TESTED BY AN INDEPENDENT TESTING FIRM WITH 10 YEARS EXPERIENCE, PRIOR TO INSTALLATION.

B. TESTS SHALL BE PERFORMED AT SPECIFIED TRIP SETTING TO ENSURE PROPER OPERATION.

C. RESULTS OF TEST SHALL BE FURNISHED TO OWNER FOR RECORD.

D. VERIFY FINAL TRIP SETTINGS FOR ADJUSTABLE OR INTERCHANGEABLE CIRCUIT BREAKER ELEMENTS. INSTANTANEOUS SETTINGS SHALL BE MINIMUM UNLESS NOTED OTHERWISE.

3.4 GENERAL WIRING TESTS

A. AT THE TIME OF FINAL INSPECTION AND TEST, ALL WIRING AND CONNECTIONS THROUGHOUT THE RENOVATION AREAS MUST BE COMPLETED, DEVICES AND EQUIPMENT PROPERLY OPERATING, LIGHTING FIXTURES INSTALLED, AND POWER AND LIGHTING CIRCUIT AND CONTROL WIRING CLEARLY IDENTIFIED WITH APPROVED TAGS READY FOR ACCEPTANCE. EACH SYSTEM SHALL TEST FREE FROM SHORT CIRCUIT AND GROUNDS.

B. INSULATION RESISTANCE FOR LOW VOLTAGE CABLES AND WIRING SHALL BE PERFORMED AT 1000 VOLT D.C. FOR ONE (1) MINUTE. WHEN INSULATION RESISTANCE MUST BE DETERMINED, SWITCHBOARDS, PANELBOARDS, FUSE HOLDERS, SWITCHES AND OVERCURRENT DEVICES SHALL BE IN PLACE, AND THE INSULATION RESISTANCE WHEN TESTED AT 1000 VOLTS D.C. SHALL BE NO LESS THAN 100,000 OHMS FOR #14 AND #12 WIRE AND 250,000 OHMS FOR #10 WIRE AND LARGER.

3.5 GROUNDING SYSTEM TESTS

A. TEST AND INSPECT THE MAIN GROUNDING ELECTRODE SYSTEM IN ACCORDANCE WITH SECTION 7.13 OF THE NETA HANDBOOK FOR ELECTRICAL TESTING PROCEDURES. PERFORM A RESISTANCE TO GROUND TEST AND INSURE THAT RESISTANCE IS NO GREATER THAN 5 (FIVE) OHMS. INVESTIGATE AND SUPPLEMENT GROUNDING SYSTEM WHERE RESISTANCE EXCEEDS RECOMMENDED VALUES AND RE-TEST AS REQUIRED.

B. GROUND FAULT CIRCUIT INTERRUPTION SHALL BE TESTED AFTER INSTALLATION BY RANDOM CONNECTION OF PLUG-IN TESTER TO VARIOUS PROTECTED RECEPTACLES, AS DIRECTED BY ARCHITECT.

3.6 OPERATIONAL TESTS

A. EACH PIECE OF ELECTRICAL EQUIPMENT, INCLUDING LIGHTING FIXTURES, MOTORS AND CONTROLS SHALL BE OPERATED CONTINUOUSLY FOR MINIMUM TEST PERIOD OF ONE HOUR.

B. DEMONSTRATE BY OPERATING EQUIPMENT THAT CIRCUITS AND DEVICES ARE IN GOOD OPERATING CONDITION. EACH ITEM OF CONTROL EQUIPMENT SHALL BE OPERATED MINIMUM OF FIVE TIMES. DEMONSTRATION SHALL BE PERFORMED AFTER WIRING TESTS.

3.7 MECHANICAL SYSTEM ADJUSTMENT AND TESTING

A. BE PRESENT DURING ADJUSTMENT PERIOD AND FINAL TESTING OF MECHANICAL SYSTEMS. TAKE READINGS NECESSARY TO ENSURE THAT ELECTRICAL SYSTEMS ARE OPERATING PROPERLY. TESTS FOR MECHANICAL WORK ARE DETAILED UNDER DIVISION 15, MECHANICAL WORK.

B. TAKE AMPERE READINGS WITH TRUE RMS READING AMMETER AT EACH ELECTRICAL COMPONENT, SUCH AS MOTOR AND HEATING COIL, TO DETERMINE PROPER OPERATION.

C. RECORD READINGS AND SUBMIT THEM IN TRIPLICATE TO THE ENGINEER FOR REVIEW.

3.8 FIRE ALARM SYSTEM INSTALLATION AND TESTING

A. FIRE ALARM WIRING SHALL BE RUN IN EMT; DEVICES SHALL BE SECURELY AFFIXED TO BUILDING SURFACES.

B. JUNCTION BOXES, PULL BOXES, OUTLET BOXES AND COVERS IN THE FIRE ALARM RACEWAY SYSTEM SHALL BE PAINTED RED.

C. TEST EVERY DEVICE AND OPERATION, INCLUDING TEST BY SIMULATION OF TROUBLE, IN PRESENCE OF THE OWNER AND THE ARCHITECT. NOTIFY THE OWNER, THE ARCHITECT AND INTERESTED PARTIES OF TESTING 72 HOURS IN ADVANCE.

D. THE SYSTEM AS DESCRIBED SHALL BE INSTALLED, TESTED AND DELIVERED TO THE OWNER IN FULLY OPERATIONAL AND FIRST-CLASS CONDITION. THE SYSTEM SHALL INCLUDE ALL REQUIRED HARDWARE, RACEWAYS INTERCONNECTING WIRING AND SOFTWARE TO ACCOMPLISH THE REQUIREMENTS OF THIS CONTRACT. THE FIRE ALARM EQUIPMENT SUPPLIER WILL HAVE HAD TEN (10) YEARS PREVIOUS EXPERIENCE WITH FACILITY OPERATIONS AND REQUIREMENTS.

3.9 LABELING

A. LABEL ALL NEW DISCONNECTS, STARTERS, MOTORS, FURNITURE FEEDER BOXES, IN A MANNER ACCEPTABLE TO THE ARCHITECT. PROVIDE UPDATED PANEL SCHEDULES IN ALL PANELBOARDS WITHIN THE SCOPE OF WORK.

B. ALL MANUFACTURER'S NAMEPLATES SHALL BE KEPT CLEAN AND FREE OF PAINT.

C. DATA/COMMUNICATIONS WIRING DONE UNDER THIS CONTRACT SHALL BE RECORDED ON CABLE MANAGEMENT DRAWINGS. EACH OUTLET SHALL BE ASSIGNED A NUMBER WHICH SHALL BE KEYED TO ITS PUNCHDOWN LOCATION.

D. PROVIDE PRINTED, COLORED, ADHESIVE LABELS FOR ALL ELECTRICAL EQUIPMENT, SUCH AS BUT NOT LIMITED TO SWITCHBOARDS, PANELBOARDS, MOTOR CONTROL CENTERS, DISCONNECT SWITCHES, METER SOCKET ENCLOSURES, ETC. TO WARN QUALIFIED PERSONNEL OF POTENTIAL ELECTRIC ARC FLASH HAZARDS. LABEL SHALL BE A MINIMUM OF 4" X 5" AND READ AS FOLLOWS:

WARNING

ARC FLASH HAZARD
APPROPRIATE PPE REQUIRED
FAILURE TO COMPLY CAN RESULT IN DEATH OR INJURY
REFER TO NFPA 70E

END OF SECTION

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VAN ZELM HEYWOOD & SHADFORD, INC.
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10 TALCOTT NOTCH, FARMINGTON, CT 06032 - 1800
Connecticut | Massachusetts | North Carolina

CONSULTANTS:

PROJECT NAME:
Juliet W. Long School
1854 Route 12
Gales Ferry, CT 06335

KEYPLAN

N

REVISIONS		
REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:
ELECTRICAL SPECIFICATIONS

DATE: 08/05/24
DRAWN BY: RZP
CHECKED BY: RSM
SCALE: N.T.S.
PROJ #: 2024087.00

DRAWING NUMBER:
E300

MOTOR CIRCUIT SCHEDULE

EQUIPMENT	LOCATION	SUPPLY FROM	WIRE	O.C.P. DEVICE	DISC SIZE	DISC FUSE	STARTER TYPE	STARTER SIZE	HP	VOLT/PH	NOTES
RTU-1	ROOF	MP-2	3#8, 1#8G, 1"C	40	60	40	VFD		7.5	208 3Ø	NOTES 1 AND 2
RTU-2	ROOF	MP-2	3#4, 1#6G, 1 1/4"C	90	100	90	VFD		7.5	208 3Ø	NOTES 1 AND 2
DOA-1	ROOF	MP-2	3#2, 1#4G, 1 1/2"C	200	200	125	VFD		91.5 FLA	208 3Ø	NOTES 1 AND 3
DOA-2	ROOF	MP-1	3#1, 1#4G, 2"C	200	200	125	VFD		104.7 FLA	208 3Ø	NOTES 1 AND 3
CU-1	ROOF	MP-1	3#2, 1#6G, 1 1/2"C	125	100	80	FWE		64 FLA	208 3Ø	NOTES 1
CU-2	ROOF	MP-1	3#4, 1#6G, 1 1/4"C	100	60	60	FWE		48 FLA	208 3Ø	NOTES 1
CU-3	ROOF	MP-2	3#4, 1#6G, 1 1/4"C	90	60	60	FWE		44 FLA	208 3Ø	NOTE 1
CU-4	ROOF	MP-2	3#6, 1#6G, 1"C	70	60	45	FWE		35.2 FLA	208 3Ø	NOTE 1

MOTOR CIRCUIT SCHEDULE REFERENCED NOTES:

1. REFER TO FLOOR PLANS FOR CIRCUIT/SOURCE PANEL INFORMATION.
2. VFD FURNISHED BY DIVISION 23 AND INSTALLED BY DIV. 26.POWER WIRING FROM SOURCE TO VFD BY DIV. 26. POWER WIRING BETWEEN VFD AND MOTORS BY DIV. 26. CONTROL WIRING BY DIVISION 23.
3. SINGLE POINT POWER CONNECTION UNIT WITH INTEGRAL VFDs.

MOTOR CIRCUIT SCHEDULE GENERAL NOTES:

A. REFER TO SPECIFICATIONS FOR STANDARD FEATURES.

B. ABBREVIATIONS:
VFD - VARIABLE FREQUENCY DRIVE
FVNR - FULL VOLTAGE, NON-REVERSING
RVNR - REDUCED VOLTAGE, NON-REVERSING
FHMS - FRACTIONAL HORSEPOWER MOTOR STARTER
2 SPD - TWO-SPEED, NON REVERSING
MAN - MANUAL STARTER (TOGGLE SWITCH WITH THERMAL OVERLOADS)
FWE- FURNISHED WITH EQUIPMENT.

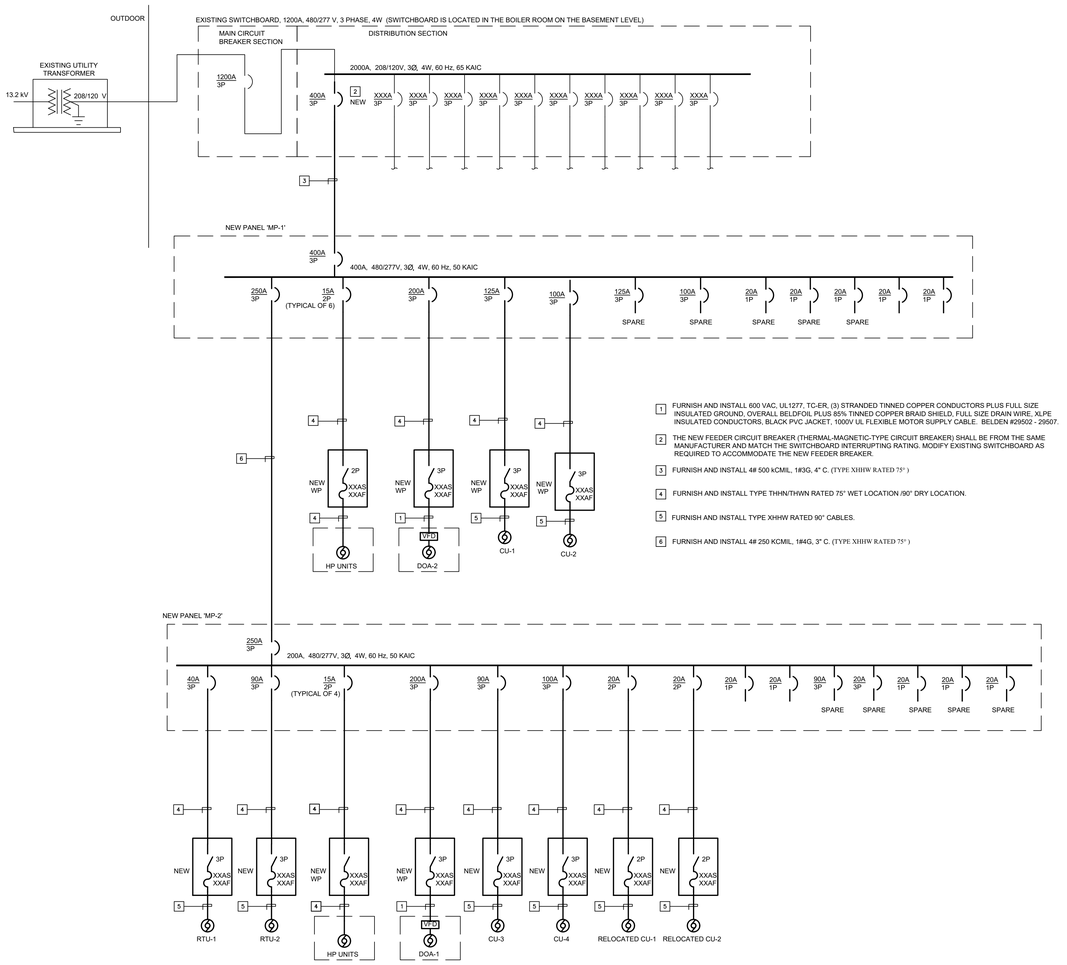
C. O.C.P. DEVICES AND LOCAL DISC. SWITCHES ARE THREE POLE UNLESS OTHERWISE NOTED.

D. LOCAL DISCONNECT SWITCH SIZE INDICATES SWITCH FRAME FOLLOWED BY FUSE SIZE (I.E. 30A/20A REPRESENTS A 30A FRAME SWITCH WITH 20A FUSES).

E. PROVIDE WEATHERPROOF FUSED DISCONNECT SWITCHES WHERE LOCATED OUTSIDE OR IN WET LOCATIONS.

F. STARTERS, DISCONNECT SWITCHES, CIRCUIT BREAKERS, BRANCH CIRCUIT WIRING, ETC. INDICATED IN THE MOTOR CIRCUIT SCHEDULE SHALL BE FURNISHED AND INSTALLED BY DIVISION 26 UNLESS OTHERWISE NOTED.

G. THE "O.C.P. DEVICE" SHALL BE A CIRCUIT BREAKER UNLESS OTHERWISE NOTED.



1. FURNISH AND INSTALL 600 VAC, UL1277, TC-ER, (3) STRANDED TINNED COPPER CONDUCTORS PLUS FULL SIZE INSULATED GROUND, OVERALL BELDFOIL PLUS 85% TINNED COPPER BRAID SHIELD, FULL SIZE DRAIN WIRE, XLPE INSULATED CONDUCTORS, BLACK PVC JACKET, 1000V UL FLEXIBLE MOTOR SUPPLY CABLE. BELDEN #29502 - 29507.
2. THE NEW FEEDER CIRCUIT BREAKER (THERMAL-MAGNETIC-TYPE CIRCUIT BREAKER) SHALL BE FROM THE SAME MANUFACTURER AND MATCH THE SWITCHBOARD INTERRUPTING RATING. MODIFY EXISTING SWITCHBOARD AS REQUIRED TO ACCOMMODATE THE NEW FEEDER BREAKER.
3. FURNISH AND INSTALL 4# 500 kCMIL, 1#3G, 4" C. (TYPE XHHW RATED 75°)
4. FURNISH AND INSTALL TYPE THHN/THWN RATED 75° WET LOCATION /90° DRY LOCATION.
5. FURNISH AND INSTALL TYPE XHHW RATED 90° CABLES.
6. FURNISH AND INSTALL 4# 250 KCMIL, 1#4G, 3" C. (TYPE XHHW RATED 75°)

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CONSULTANTS:

PROJECT NAME:
Juliet W. Long School
1854 Route 12
Gales Ferry, CT 06335

KEYPLAN

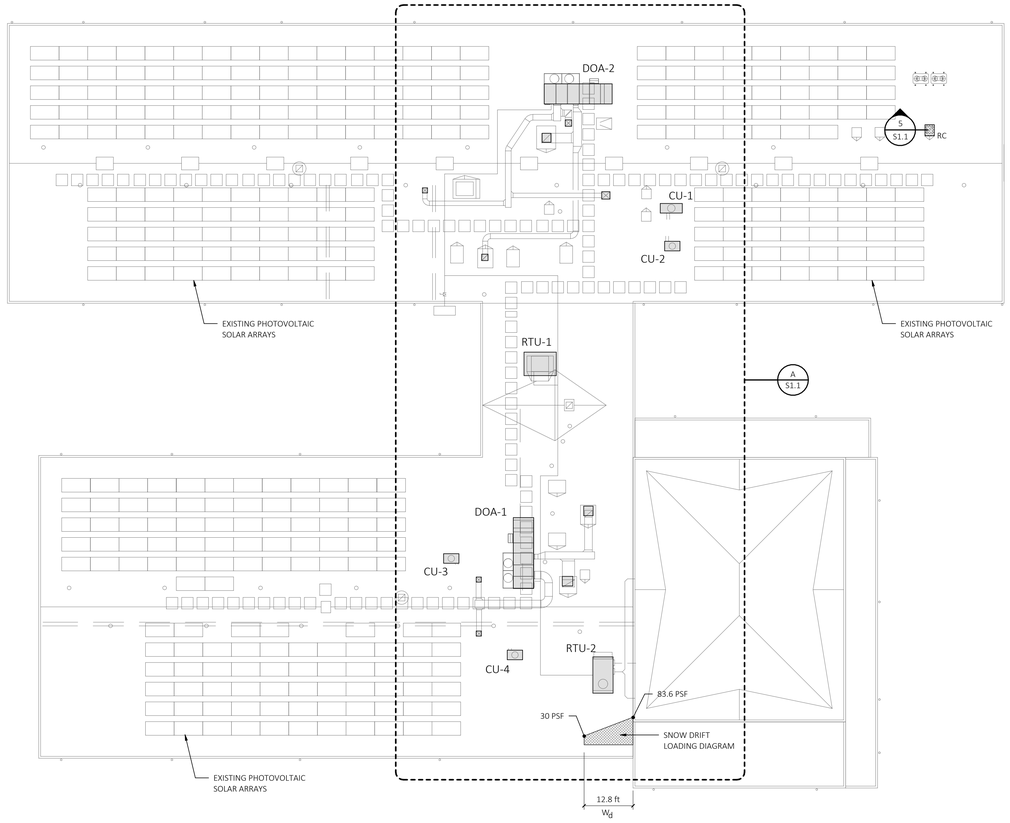
REVISIONS

REV. NO.	DATE	DESCRIPTION

DRAWING TITLE:
ELECTRICAL SCHEDULES AND ONE-LINE RISER DIAGRAM

DATE: 08/05/24
DRAWN BY: RZP
CHECKED BY: RSM
SCALE: N.T.S.
PROJ #: 2024087.00

DRAWING NUMBER:
E400



ROOF FRAMING KEY PLAN

1/16" = 1'-0"

STRUCTURAL NOTES

A. GENERAL

A1. UNLESS OTHERWISE NOTED WITHIN THE STRUCTURAL DRAWINGS, THE SECTIONS AND DETAILS SHOWN SHALL BE CONSIDERED TYPICAL AND CONTIGUOUS AND SHALL BE APPLICABLE TO SIMILAR CONDITIONS WITHIN THE PROJECT SCOPE.

A2. THE STRUCTURAL DRAWINGS, INCLUDING ALL PLANS, SECTIONS, DETAILS AND SPECIFICATIONS, SHALL BE USED IN CONJUNCTION WITH THE ARCHITECTURAL DRAWINGS, SITE/CIVIL/LANDSCAPE DRAWINGS, MECHANICAL/ELECTRICAL/PLUMBING DRAWINGS AND VENDOR CERTIFIED DIMENSION DRAWINGS TO PREPARE SHOP DRAWINGS WITH SUFFICIENT DETAIL AND DIMENSIONS TO COMPLETE THE WORK.

A3. PRIOR TO THE START OF CONSTRUCTION THE CONTRACTORS SHALL VERIFY ALL EXISTING CONDITIONS THAT WILL EFFECT THE LAYOUT AND SEQUENCING OF THE WORK.

A4. EXISTING BUILDING INFORMATION, DIMENSIONS AND ELEVATIONS ARE TAKEN FROM OWNER PROVIDED DRAWINGS AND SHALL BE VERIFIED IN THE FIELD BY THE CONTRACTORS. INCONSISTENCIES BETWEEN EXISTING CONDITIONS AND THE INFORMATION PROVIDED IN THESE DOCUMENTS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER FOR INTERPRETATION AND DIRECTION.

A5. ATTACHMENT AND SUPPORT OF MECHANICAL EQUIPMENT SHALL FOLLOW THE MANUFACTURER INSTALLATION INSTRUCTIONS.

A6. THE STRUCTURE HAS BEEN ENGINEERED TO BE SELF SUPPORTING ONCE THE WORK IS COMPLETE. THE CONTRACTOR HAS SOLE RESPONSIBILITY FOR THE STRUCTURES STABILITY DURING CONSTRUCTION INCLUDING MEANS METHODS OF ERECTION, TEMPORARY SHORING AND TEMPORARY BRACING.

A7. THE CONTRACTOR SHALL PROVIDE AND BE RESPONSIBLE FOR FOLLOWING ALL APPLICABLE SAFETY CODES AND REGULATIONS DURING ALL PHASES OF THE WORK.

A8. INSPECTION AND MATERIALS TESTING SHALL BE AS SPECIFIED IN THE DRAWINGS AND THE "SCHEDULE OF SPECIAL INSPECTIONS" DOCUMENT.

A9. ALL MECHANICAL OR ADHESIVE ANCHORS SHALL BE INSTALLED IN STRICT ACCORDANCE WITH THE MANUFACTURERS WRITTEN INSTALLATION REQUIREMENTS.

A10. CONTRACTOR SHALL VERIFY SIZE AND LOCATION OF ALL ROOF AND FLOOR OPENINGS WITH ARCHITECTURAL AND MECHANICAL, ELECTRICAL AND PLUMBING DRAWINGS.

B. DESIGN INFORMATION

B1. ALTERATIONS TO THE BUILDING STRUCTURE HAVE BEEN ENGINEERED IN ACCORDANCE WITH THE APPLICABLE STRUCTURAL PROVISIONS IN THE BUILDING CODE LISTED IN THE DESIGN DATA TABLE.

B2. REFER TO THE DESIGN DATA TABLE FOR THE APPLICABLE CODES AND DESIGN REFERENCES USED IN THE ENGINEERING OF WORK PRESENTED IN THESE DOCUMENTS.

B3. REFER TO THE DESIGN DATA TABLE FOR LIVE LOADS, SNOW LOADS, WIND LOADS, SEISMIC LOADS AND RELATED DESIGN PARAMETERS.

B4. THE ALLOWABLE SOIL BEARING CAPACITY HAS BEEN ASSUMED TO BE AS LISTED WITHIN DESIGN DATA TABLE FOR SHALLOW FOUNDATION DESIGN. THIS BEARING CAPACITY SHALL BE VERIFIED IN THE FIELD BY A QUALIFIED GEOTECHNICAL ENGINEER ENGAGED BY THE OWNER. FOOTINGS SHALL NOT BE PLACED WITHOUT APPROVAL FROM THE GEOTECHNICAL ENGINEER.

B5. THE DESIGN LOADING FOR MECHANICAL EQUIPMENT SPECIFIED IN THE WORK IS BASED ON THE OPERATIONAL WEIGHT AND DYNAMIC FORCES PUBLISHED IN MANUFACTURERS CUT SHEET DATA AT THE TIME OF THE DESIGN.

C. BUILDING EARTHWORK

C1. NOT IN PROJECT SCOPE

D. FOOTINGS

D1. NOT IN PROJECT SCOPE

E. CONCRETE

E1. NOT IN PROJECT SCOPE

F. STRUCTURAL STEEL

F1. ALL CONNECTIONS SHALL BE DETAILED BY THE STEEL FABRICATOR TO SUPPORT THE UNIFORM LOAD TABLE'S MAXIMUM UNIFORM LOAD AS CALLED FOR IN THE A.I.S.C. UNLESS THE REACTIONS ARE INDICATED ON THE PLANS.

F2. WELDING TO EXISTING STEEL SURFACES SHALL BE CONDUCTED IN ACCORDANCE WITH AWS D1.1 REQUIREMENTS. WHEN WELDING SURFACE PREPARATION REQUIRES THE REMOVAL OF PAINT THE OWNER SHALL PROVIDE APPROPRIATE DOCUMENTATION AS TO THE IDENTIFICATION OF ANY LEAD BASED PAINT AND SHALL PROVIDE THE REMOVAL OR ABATEMENT OF LEAD BASED PAINT IN THE AREA TO BE WELDED. REMOVAL AND DISPOSAL OF LEAD BASED PAINT SHALL BE IN ACCORDANCE WITH ALL FEDERAL, STATE AND LOCAL REGULATIONS.

F3. ALL BOLTED CONNECTIONS SHALL USE HIGH STRENGTH A325 OR A490 BOLTS

F4. ALL WELDED CONNECTIONS SHALL USE E70-XX ELECTRODES

F5. STAIR FRAMING ARRANGEMENT SHOWN FOR GENERAL LOAD PATH ONLY. SEE SPECIFICATIONS FOR ENGINEERING REQUIREMENTS. REFER TO ARCHITECTS DRAWINGS FOR RAILINGS, STRINGERS, RISERS, TREADS, HANDRAILS, MISCELLANEOUS STEEL.

F6. ALL STEEL AND CONNECTING HARDWARE EXPOSED TO THE WEATHER SHALL BE HOT-DIP GALVANIZED IN ACCORDANCE WITH ASTM A123, ASTM 153, OR ASTM A653 AS APPLICABLE.

G. UNIT MASONRY

G1. CONCRETE MASONRY CONSTRUCTION WORK SHALL CONFORM TO : BUILDING CODE REQUIREMENTS FOR MASONRY STRUCTURES ACI 530/530R-14 SPECIFICATIONS FOR MASONRY STRUCTURES ACI 530.1/530.1R-14

G2. CONCRETE MASONRY STRENGTH F'm SHALL BE NOT LESS THAN 1,500 PSI.

G3. CONCRETE MASONRY UNITS SHALL CONFORM TO ASTM C90, TYPE 1

G4. MORTAR FOR REINFORCED CMU SHALL CONFORM TO ASTM C270, TYPE S.

G5. GROUT SHALL CONFORM TO ASTM C476, FINE TYPE WITH A MINIMUM 28-DAY COMPRESSIVE STRENGTH OF 2,500 PSI. CONCRETE MASONRY WALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH LOW LIFT GROUTING METHOD.

G6. HORIZONTAL JOINT REINFORCING SHALL CONFORM TO ASTM A82, # 9 WIRE SPACED AT 16" o.c. VERTICALLY.

G7. VERTICAL REINFORCING BARS SHALL CONFORM TO ASTM A615, GRADE 60 DEFORMED BARS.

G8. HOT-DIP GALVANIZED LINTELS SHALL BE PROVIDED IN ALL NEW OPENINGS IN EXISTING MASONRY. PROVIDE ONE- L 4 x 3 1/2 x 3/8 FOR EVERY 4" OF MASONRY WALL THICKNESS. PROVIDE 4" BEARING AT EACH END. MAXIMUM MASONRY OPENING 48".

H. ROUGH CARPENTRY

H1. SAWN LUMBER SHALL BE SPRUCE-PINE-FIR (SPF) NO. 2 OR BETTER GRADE.

H1. WOOD EXPOSED TO WEATHER OR IN CONTACT WITH CONCRETE FOUNDATIONS SHALL BE PRESSURE TREATED SOUTHER PINE NO 2. OR BETTER .

H1. ENGINEERED LUMBER REFERENCED IN THESE PLANS ARE BASED ON WEYERHAEUSER MANUFACTURER PRODUCT LINES. MANUFACTURER SUBSTITUTIONS SHALL BE EQUAL IN MATERIAL AND SECTION PROPERTIES FOR THE WEYERHAEUSER SIZES INDICATED.

H1. NAILING OF WOOD MEMBERS SHALL BE IN ACCORDANCE WITH IBC 2015 TABLE 2304.10.1 FASTENING SCHEDULE. UNLESS OTHERWISE NOTED.

H1. FLOOR SHEATHING SHALL BE A MINUMUM OF 3/4" EXTERIOR GRADE PLYWOOD NAILED TO FLOOR FRAMING WITH 10d COMMON NAILS AT 6" o.c. ALONG PANEL EDGES AND 12" IN THE FIELD, UNBLOCKED.

i. COLD FORMED LIGHT GAGE METAL FRAMING

i1. SYSTEM COMPONENTS: MANUFACTURER'S STANDARD LOAD-BEARING STEEL STUDS AND JOISTS OF TYPE, SIZE, AND SHAPE AS INDICATED IN THE DRAWINGS. WITH EACH TYPE OF METAL FRAMING REQUIRED, PROVIDE MANUFACTURER'S STANDARD STEEL RUNNERS (TRACKS), BLOCKING, LINTELS, CLIP ANGLES, SHOES, REINFORCEMENTS, FASTENERS, AND ACCESSORIES FOR APPLICATIONS INDICATED AS NEEDED TO PROVIDE A COMPLETE METAL FRAMING SYSTEM.

i2. MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS OF ONE OF THE FOLLOWING:

1. DALE INDUSTRIES, INC.
2. DIETRICH INDUSTRIES, INC.
3. MARINO INDUSTRIES, INC.

i3. MATERIALS AND FINISHES OF COLD FORMED METAL FRAMING SHALL BE AS FOLLOWS:

1. FOR 16 GAGE AND HEAVIER UNITS, FABRICATE METAL FRAMING COMPONENTS OF STRUCTURAL QUALITY STEEL SHEET WITH A MINIMUM YIELD POINT OF 40,000 P.S.I.; A.S.T.M. A-570 OR A-611.
2. FOR 18 GAGE AND LIGHTER UNITS, FABRICATE A METAL FRAMING COMPONENTS OF COMMERCIAL QUALITY STEEL SHEET WITH A MINIMUM YIELD POINT OF 33,000 P.S.I.; A.S.T.M. A-446, A-570, OR A-611.
3. PROVIDE GALVANIZED FINISH TO METAL FRAMING COMPONENTS COMPLYING WITH A.S.T.M. A-653 FOR MINIMUM G60 COATING.
4. FASTENERS; PROVIDE NUTS, BOLTS, WASHERS, SCREWS, AND OTHER FASTENERS WITH CORROSION-RESISTANT PLATED FINISH.
5. GALVANIZING REPAIR; WHERE GALVANIZED SURFACES ARE DAMAGED, PREPARE SURFACES AND REPAIR IN ACCORDANCE WITH PROCEDURES SPECIFIED IN A.S.T.M. A-780.

i4. ATTACH SIMILAR COMPONENTS BY WELDING OR SCREWING. ATTACH DISSIMILAR COMPONENTS BY WELDING, BOLTING, OR SCREW FASTENERS, AS STANDARD WITH MANUFACTURER.

i5. FABRICATION AND INSTALLATION OF CFMF SHALL COMPLY WITH AISI'S "NORTH AMERICAN SPECIFICATION FOR THE DESIGN OF COLD-FORMED STEEL STRUCTURAL MEMBERS" AND ITS "STANDARD FOR COLD-FORMED STEEL FRAMING - GENERAL PROVISIONS."

ABBREVIATIONS

ARCH.	ARCHITECTURAL
B.	BOTTOM
B.F.	BOTTOM OF FOOTING
BP	BEARING PLATE
C.C.	CENTER TO CENTER
C.J.	CONTROL JOINT
CANTIL.	CANTILEVER
CONC.	CONCRETE
DIA.	DIAMETER
do.	DITO/SAME
DWG.	DRAWING
EA.	EACH
E.J.	EXPANSION JOINT
ELEV.	ELEVATION
F.P.	FIREPROOFING
HD	HOLD DOWN
HKP	HOUSEKEEPING PAD
k	KIP
K*Ft	KIP-FOOT
LBS.	POUNDS
LGMF	LIGHT GAGE METAL FRAMING
LSL	LAMINATED STRAND LUMBER
LVL	LAMINATED VENEER LUMBER
MEP	MECHANICAL ELECTRICAL PLUMBING
NP	NEW PENETRATION
O.C.	ON CENTER
O.F.	OUTSIDE FACE
P.A.F.	POWDER ACTUATED FASTENER
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSL	PARALLEL STRAND LUMBER
P/C	PRE-CAST
RC	REMOVE AND CAP
REINF.	REINFORCED
S.F.	STEP FOOTING
SIM.	SIMILAR
STL.	STEEL
SW	SHEAR WALL
T.	TOP
T.P.	TOP OF PIER
T.S.	TOP OF SHELF
T.W.	TOP OF WALL
TYP.	TYPICAL
U.O.N.	UNLESS OTHERWISE NOTED
W.W.F.	WELDED WIRE FABRIC
WD.	WOOD
WF	WIDE FLANGE

DESIGN DATA

CODES USED

2022 CONNECTICUT STATE BUILDING CODE
2021 INTERNATIONAL BUILDING CODE
2021 INTERNATIONAL EXISTING BUILDING CODE
ACI 318-19
ANSI/AISC 360-16
ASCE/SEI 7-16

DESIGN STRESSES USED

STRUCTURAL STEEL SHAPES	ASTM - A992 F_y = 50 ksi
MISC. ANGLES AND PLATES	ASTM - A36 F_y = 36 ksi
HOLLOW STRUCTURAL STEEL - RECT.	ASTM - A500 GRADE B
CONCRETE	f'_c AT 28 DAYS 3,500 psi
REINFORCING STEEL	ASTM - GRADE 60
CONCRETE MASONRY	f'_m 1,500 psi
GROUT COMPRESSIVE STRENGTH	2,000 psi
MORTAR FOR BLOCK	TYPE S
SOIL BEARING CAPACITY	2,000 PSF

LIVE LOADS

ROOFS	20 PSF

SNOW LOADS

GROUND SNOW LOAD	P_g = 30.0 PSF
SNOW THERMAL FACTOR	C_t = 1.0
SNOW EXPOSURE FACTOR	C_e = 1.0
BUILDING CATEGORY	CATEGORY III
SNOW IMPORTANCE FACTOR	I_s = 1.1

WIND LOADS

BASIC WIND SPEED	140 MPH
BUILDING RISK CATEGORY	CATEGORY III
WIND EXPOSURE CATEGORY	C
INTERNAL PRESSURE COEFFICIENT	GC_{pi} = +/- 0.18

SEISMIC DATA

ANALYSIS PROCEDURE	EQUIVALENT LATERAL FORCE
BUILDING RISK CATEGORY	CATEGORY III
SEISMIC IMPORTANCE FACTOR	I_s = 1.25
MAPPED SPECTRAL RESPONSE ACCELERATION, SHORT	S_s = 0.190
MAPPED SPECTRAL RESPONSE ACCELERATION, 1-sec	S_1 = 0.053
SITE CLASS	D
DESIGN SPECTRAL RESPONSE ACCELERATION, SHORT	S_{DS} = 0.203
DESIGN SPECTRAL RESPONSE ACCELERATION, 1-sec	S_{D1} = 0.085
SEISMIC DESIGN CATEGORY	B
RESPONSE MODIFICATION FACTOR	R = 1.5
SEISMIC RESPONSE COEFFICIENT	C_S = 0.161
DESIGN BASE SHEAR	UNCHANGED FROM EXISTING
BASIC SEISMIC FORCE-RESISTING SYSTEM	EXISTING UNALTERED

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CONSULTANTS:

STRUCTURAL ENGINEER:
GIRARD & CO. ENGINEERS, LLC
10 Waterchase Drive
Rocky Hill, CT
(860) 563-3820

PROJECT NAME:

HVAC Upgrades
Juliet W. Long School
1854 Route 12
Gales Ferry, CT 06335

KEYPLAN

ISSUED FOR BID

REVISIONS

REV No	DATE	DESCRIPTION

DRAWING TITLE:

DESIGN DATA AND ROOF KEY PLAN

DATE: 2/2/2024
DRAWN BY: KB/KA
CHECKED BY: KA
SCALE: As indicated
PROJ #: 24001

DRAWING NUMBER:

S1.0

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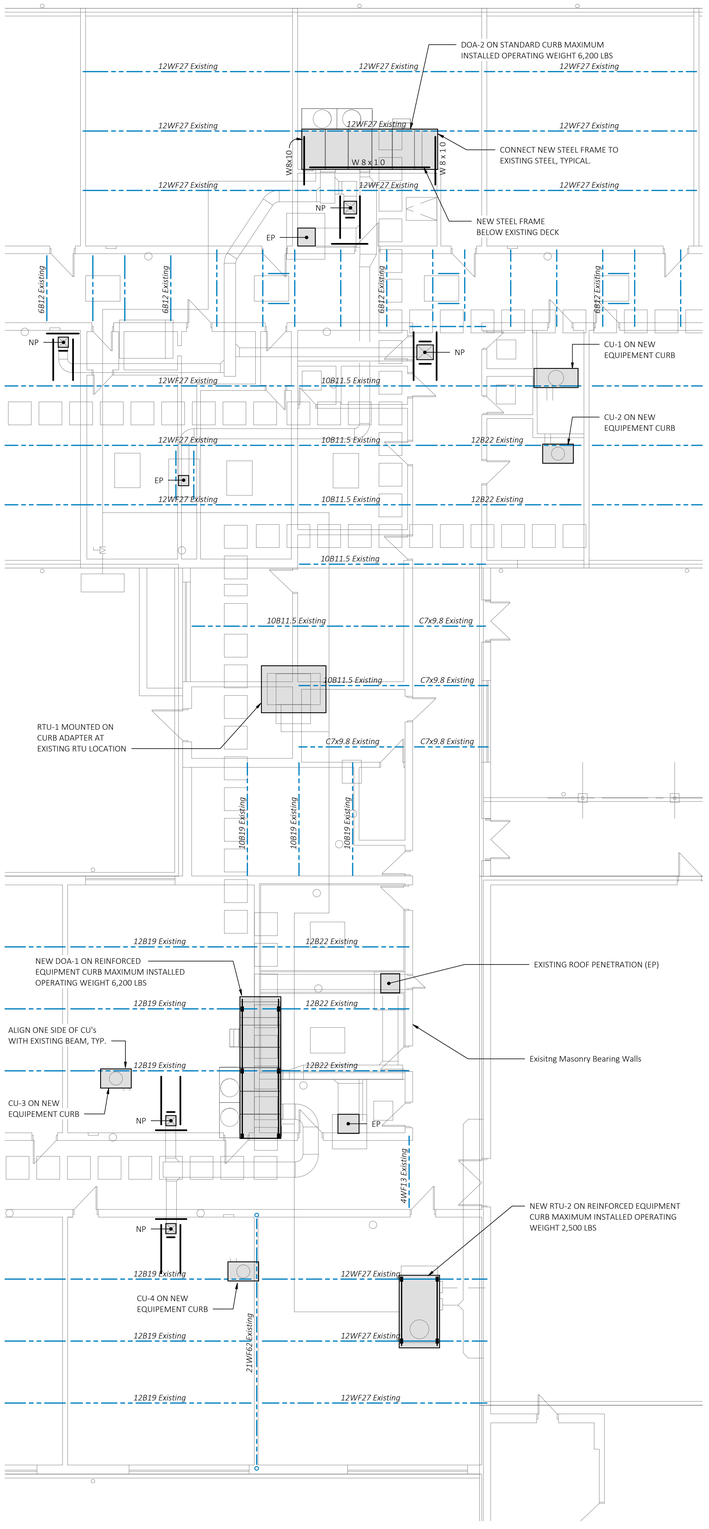
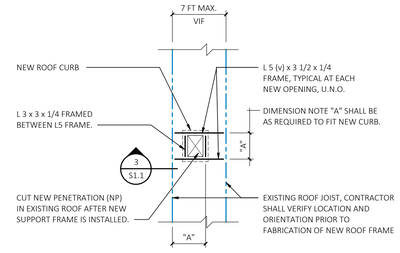


PARTIAL ROOF FRAMING PLAN

1/8" = 1'-0"

A S1.1



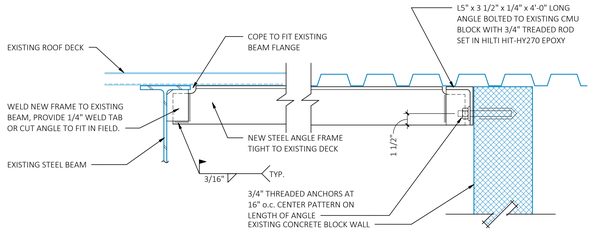
TYPICAL STEEL DECK PENETRATION SUPPORT FRAME

NOT TO SCALE

1 S1.1

NOTES:

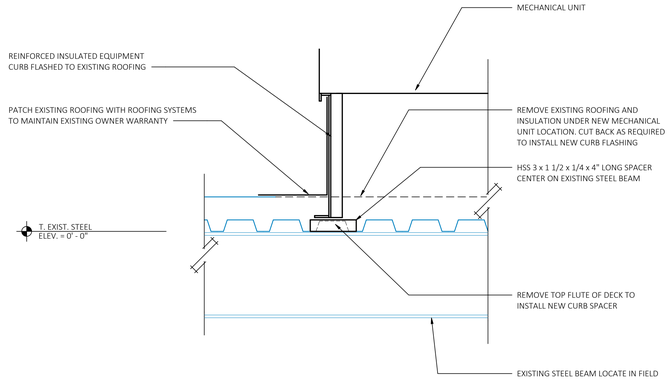
1. THE GENERAL CONTRACTOR SHALL COORDINATE DIMENSIONS NOTED AS "A" WITH THE MECHANICAL CONTRACTOR AND THE FIELD CONDITIONS.
2. FASTEN EXISTING METAL DECK TO THE NEW STEEL FRAME WITH SELF-TAP SCREWS AT 6" o.c. AROUND THE PERIMETER OF THE NEW OPENING.



TYPICAL ROOF FRAME CONNECTION DETAIL

1 1/2" = 1'-0"

3 S1.1

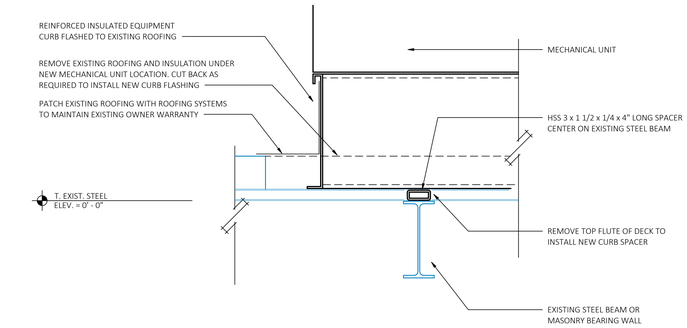


SECTION

1 1/2" = 1'-0"

2 S1.1

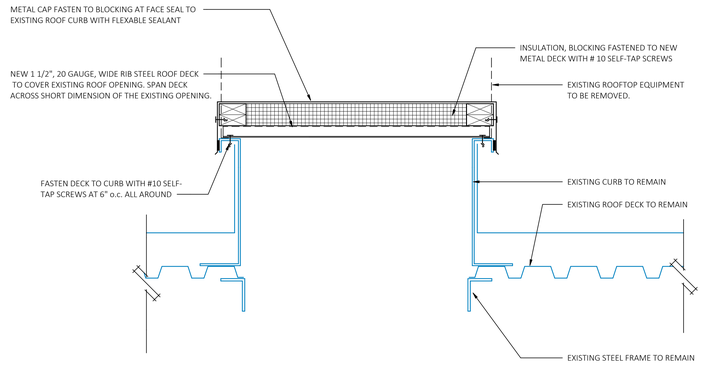
NOTE:
CURB DEPTH VARRIES TO ACCOMODATE EXISTING ROOF PITCH. SET TOP OF PREFABRICATED CURB LEVEL.



SECTION

1 1/2" = 1'-0"

4 S1.1



TYPICAL EXHAUST FAN CAP DETAIL

1 1/2" = 1'-0"

5 S1.1

NOTES:

1. ROOF CAP SHALL BE PROVIDED FOR ALL EXISTING ROOF OPENINGS TO BE INFILLED. REFER TO MECHANICAL DRAWINGS FOR MECHANICAL UNITS TO BE REMOVED AND OTHER AREAS TO BE INFILLED.
2. MAXIMUM OPENING DIMENSION 36" CLEAR

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PROJECT NAME:

HVAC Upgrades
Juliet W. Long School
1854 Route 12
Gales Ferry, CT 06335

320

KEYPLAN

ISSUED FOR BID

REVISIONS

REV No	DATE	DESCRIPTION

DRAWING TITLE:

FRAMING PLANS

DATE: 6/3/24
DRAWN BY: KB/KA
CHECKED BY: KA
SCALE: As indicated
PROJ #: 24001

DRAWING NUMBER:

S1.1

6/3/2024 2:27:31 PM
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TOWN OF LEDYARD
CONNECTICUT
PERMANENT MUNICIPAL BUILDING COMITTEE

741 Colonel Ledyard Hwy
Ledyard, Connecticut 06339
860-464-3222

Chairman Jospeh Gush

April 7, 2025

Chairman S. Naomi Rodriguez
Town of Ledyard
741 Colonel Ledyard Highway
Ledyard, CT 06339

Dear Chairman Rodriguez:

At the Permanent Municipal Building Committee's March 31, 2025 meeting we approved a request to the Town Council to increase the Board of Education $8,550,000 Roof Replacement and Various School Projects by an additional $1,250,000; bringing the total requested Bond Authorization to $9,800,000 to proceed with the Juliet W. Long Heating Ventilation and Air Conditioning System Project.

The request to the Town to consider increasing the Bond Authorization was based on the following:

- The results of rebid #LPS-24-9 (Ledyard Public Schools HVAC Replacement); for which three bids were received.
- The rebid allowed Contractors the ability to complete the project over the summer of 2025 and 2026, during school holidays and breaks, and with limited work while school is in session.
- The initial estimate for the project was $2,225,000. Nutmeg Companies Inc., in the amount of $2,673,520 was the low bidder to the project rebid. Based upon the rebid results, the total revised cost estimate provided by Friar Architecture for the project is $3,362,656. Additional estimated costs beyond that were added for bonding and insurance resulting in a revised estimated budget of $3,475,000.
- The HVAC Project at Juliet W. Long School will need to be completed by December 31, 2026 (extended from the original date of December 31,2025) for the town to be eligible to receive reimbursement in the amount of 61.78% of eligible project costs up to $2,225,000. The maximum grant reimbursement would be 61.78% of eligible project costs or $1,374,605. Project cost over $2,225,000 will not be eligible for State reimbursement.
- Nutmeg Companies, Inc., indicated that work can be complete by December 2025 if work can begin this summer. It should be noted that if work is unable to commence in Summer 2025, escalation costs will be incurred.

As you are aware the PMBC and Ledyard Public Schools have solicited bids for this project several times, and each time the project has come in higher than the estimated amount based on a number of issues which included the need to redesign the HVAC System to meet the State's new grant eligibility guidelines.

The PMBC Respectfully requests the Town Council take the necessary steps to obtain Bond Authorization Documents and to present this request for a supplemental authorization in the amount of $1,250,000 to the townspeople at the May 20, 2025 Annual Budget Referendum, in an effort to get this project underway at the end of this school year.

Although there is not a guarantee that the Contractor will be able to get materials ordered, delivered and on-site by June, 2025 to begin their work to install the HVAC System at Juliet W. Long School, time is of the essence in an effort to try and comply with the State's December 2026 deadline, otherwise Ledyard would forgo our eligibility for the Grant Reimbursement funding.

Members of the PMBC will make themselves available to answer questions, and or attend meetings to help the Town Council understand the urgency of our request, and to assist with working to get the Juliet W. Long HVAC Project underway and to the finish line.

The Town Council's prompt attention and consideration regarding this important request would be greatly appreciated.

Respectfully,

Joseph Gush
Chairman
Permanent Municipal Building Committee

Enclosures: Nutmeg Companies Inc. Bid Document, Friar Architecture Budget Tabulation
cc: Mayor Fred B. Allyn III, Superintendent Jason Hartling, Board of Education Members, Finance Director, BOE Facilities Director

Ledyard Public Schools HVAC Replacement

Juliet W. Long Elementary School – 1854 CT-12, Gales Ferry, CT 06335

FRIAR
architecture
interior design
master planning

Project Budget Tabulation
Date: 3/31/2025

		Base Bid Amount
1	A/E Design Fees	$240,440
2	Owners Rep	$50,000
3	Base Bid Contract (Nutmeg)	$2,673,520
4	Alternate 3 (Add)CO2 Monitoring	$3,000
5	Town Performed Work - (Ceilings)	$60,000
6	Commissioning Agent	$30,000
7	Owners Contingency 10%	$305,696
	Total	**$3,362,656**

Additional estimated costs (Bonding, Insurance)	$112,344
*Added during PMBC meeting	
Total Estimated Project Cost	**$3,475,000**

File #: 25-2276 **Agenda Date:** 9/8/2025 **Agenda #:** 2.

REPORT

Staff/Committee Report:
JWL HVAC Owner's Project Management Report - Colliers

FINANCIAL STATUS REPORT

Colliers
Project Leaders

Town of Ledyard

Juliet W. Long HVAC Project

Contingency Status Report

Date: 9/5/2025

Item #	Description	Vendor	Change Order Request	Change Order Number	Budget Block Code	Requested By	Origination Date	Estimated Cost	Additional Schedule Days	Status	SOURCES: Field Conditions	SOURCES: Owner Request	SOURCES: 3rd Party/ AHJ	SOURCES: Errors & Omissions	APPROVALS: Date Approved	APPROVALS: Approved By	APPROVALS: Approved Funding	A - Construction: Actual Cost	A - Construction: Balance	B - Owner's Project: Actual Cost	B - Owner's Project: Balance
										Approved, Pending-C, Pending-O, Rejected, Deferrable									371,900.00		-
1	Split electrical feeds to MP-1 and MP-2 vs running all power through MP-1.	Nutmeg Companies			I.A	Wayne Donaldson	7/9/2025	33,553.30		Pending-C		Yes							371,900.00		-
2	Filtered registers in tunnel ductowrk	Nutmeg Companies			I.A	Wayne Donaldson	7/16/2025	13,200.00		Pending-C		Yes							371,900.00		-
3	Credit back for CM allowance	Nutmeg Companies		1	I.A	Colliers	7/16/2025	(200,514.00)		Approved		Yes			8/4/2025	PMBC	(200,514.00)	(200,514.00)	572,414.00		-
4	Add smoke detector to RTU-1	Nutmeg Companies			I.A	Fire Marshal	8/13/2025	1,500.00		Pending-C			Yes						572,414.00		-
5	ASI-01: Smoke Ceiling of Penetrations, requested by the fire marshal	Nutmeg Companies		???	I.A	Fire Marshal	8/25/2025	10,000.00		Pending-C			Yes						572,414.00		-
				X							Yes										
				X							Yes										
				X							Yes										
				X							Yes										
				X							Yes										
				X							Yes										
				X							Yes										
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				X							Yes										
				X							Yes										
				X							Yes										
				X							Yes										
				X							Yes										
				X							Yes										
				X							Yes										

Town of Ledyard

Juliet W. Long HVAC Project

Contingency Status Report

Date: 9/5/2025

											SOURCES				APPROVALS			A - Construction		B - Owner's Project	
Item #	Description	Vendor	Change Order Request	Change Order Number	Budget Block Code	Requested By	Origination Date	Estimated Cost	Additional Schedule Days	Status	Field Conditions	Owner Request	3rd Party/ AHJ	Errors & Omissions	Date Approved	Approved By	Approved Funding	Actual Cost	Balance	Actual Cost	Balance
				X							Yes										
				X							Yes										
				X							Yes										
				X							Yes										
				X							Yes										
				X							Yes										
				X							Yes										
				X							Yes										
		Planned "TBD"=						-									TOTAL USED TO DATE:	(200,514.00)		-	

	Sources		
	Field Conditions	Owner Request	3rd Party/ AHJ
Approved	-	(200,514.00)	-
Pending	-	46,753.30	11,500.00
TOTAL	-	(153,760.70)	11,500.00

Errors & Omissions	
Contract Limit	Actual
$ -	-
	-
-	-

Contingency Status			
	Total Contingency Budget	Less Approved Expenditures	Less Pending Issues
Construction	371,900.00	200,514.00	(58,253.00)
Owners	-	-	-
Total	371,900.00	200,514.00	(58,253.00)

Additional Deferrable Items -

FINANCIAL STATUS REPORT

Town of Ledyard

Juliet W. Long HVAC Project

Financial Status Report ($000's)

Date: September 5, 2025

	Budget developed as of 7/15/2025	A Budget Project Budget	B Budget Approved Transfers	C Budget Approved Budget w/ Transfers	D1 Contracted Project Costs Paid	D2 Contracted Project Costs Unpaid	D Contracted Project Costs Total Contract	E Anticipated Costs Planned, but not Contracted	F Anticipated Costs Anticipated Total Costs (D + E)	G Remaining Balance (C - F)
I.	**Building Construction**									
A.	HVAC Improvements	$ 2,673.5	$ (200.5)	$ 2,473.0	$ 1,276.5	$ 1,196.5	$ 2,473.0	$ -	$ 2,473.0	$ -
B.	Soffits, Ceilings & Lights	50.0	-	50.0	4.2	-	4.2	50.0	54.2	(4.2)
	Total Building Construction	2,723.5	(200.5)	2,523.0	1,280.7	1,196.5	2,477.2	50.0	2,527.2	(4.2)
II.	**Related Construction**									
A.	Sitework	-	-	-	-	-	-	-	-	-
B.	Site Utility Systems		-	-	-	-	-	-	-	-
C.	Building Demolition		-	-	-	-	-	-	-	-
D.	Hazardous Material Removal		-	-	-	-	-	-	-	-
E.	Sustainable Elements		-	-	-	-	-	-	-	-
	Total Related Construction	-	-	-	-	-	-	-	-	-
III.	**Escalation**	-		-	-	-	-	-	-	-
	Total Construction	$ 2,723.5	$ (200.5)	$ 2,523.0	$ 1,280.7	$ 1,196.5	$ 2,477.2	$ 50.0	$ 2,527.2	$ (4.2)
IV.	**Furniture, Fixtures & Equipment (FF&E)**									
A.	Loose Furnishings	-	-	-	-	-	-	-	-	-
B.	Program Related Equipment	-	-	-	-	-	-	-	-	-
C.	Data/Telecomm Equipt	-	-	-	-	-	-	-	-	-
D.	Playground Equipment		-	-	-	-	-	-	-	-
E.	Security Equipment		-	-	-	-	-	-	-	-
F.	Specialty Signage		-	-	-	-	-	-	-	-
	Total FF & E	-	-	-	-	-	-	-	-	-

FINANCIAL STATUS REPORT

Town of Ledyard

Juliet W. Long HVAC Project

Financial Status Report ($000's)

Date: September 5, 2025

		A	B	C	D1	D2	D	E	F	G
		Budget			Contracted Project Costs			Anticipated Costs		
	Budget developed as of 7/15/2025	Project Budget	Approved Transfers	Approved Budget w/ Transfers	Paid	Unpaid	Total Contract	Planned, but not Contracted	Anticipated Total Costs (D + E)	Remaining Balance (C - F)
V.	**Fees and Expenses**									
A.	Fees									
1	Existing Conditions & Space Program		-	-	-	-	-	-	-	-
2	Architect	224.6	-	224.6	179.3	60.4	239.7	-	239.7	(15.1)
a	MEP (Van Zelm)	15.0	-	15.0	15.0	-	15.0	-	15.0	-
b	Landscape Arch.	w/ architect								
c	Structural Engineering	w/ architect								
d	NOT USED									
e	Interior/Furniture Designer									
f	Lighting Consultant									
g	Acoustical Consultant									
h	Signage Consultant									
i	LEED Designer									
j	Referendum Services									
k	Code Consultant	w/ architect								
l	Designer's Cost Estimator	w/ architect								
3	Special Consultants									
a	Haz. Mat. Consultant	-	-	-	-	-	-	-	-	-
b	Audio/Visual		-	-	-	-	-	-	-	-
c	Technology & Security Consultant	-	-	-	-	-	-	-	-	-
d	Geo-Tech Engineering		-	-	-	-	-	-	-	-
e	Traffic Engineer		-	-	-	-	-	-	-	-
f	Ecologist/Soil Sample		-	-	-	-	-	-	-	-
g	Peer Reviews		-	-	-	-	-	-	-	-
h	Green Building Consultant	w/ architect								
i	Storm Water Monitoring		-	-	-	-	-	-	-	-
4	Project Management	110.0	-	110.0	16.3	93.7	110.0	-	110.0	-
5	Building Commissioning	25.0	-	25.0	-	25.0	25.0	-	25.0	-
6	Owner's Cost Estimator		-	-	-	-	-	-	-	-
7	Owner's Legal Fees		-	-	0.5	-	0.5	-	0.5	(0.5)
8	CM Preconstruction Fee		-	-	-	-	-	-	-	-
9	Site Survey		-	-	-	-	-	-	-	-
10	Utility Assessment		-	-	-	-	-	-	-	-
	Sub-total Fees	374.6	-	374.6	211.1	179.1	390.2	-	390.2	(15.6)

FINANCIAL STATUS REPORT

Town of Ledyard

Juliet W. Long HVAC Project

Financial Status Report ($000's)

Date: September 5, 2025

		A	B	C	D1	D2	D	E	F	G
		Budget			Contracted Project Costs			Anticipated Costs		
	Budget developed as of 7/15/2025	Project Budget	Approved Transfers	Approved Budget w/ Transfers	Paid	Unpaid	Total Contract	Planned, but not Contracted	Anticipated Total Costs (D + E)	Remaining Balance (C - F)
B.	Expenses									
1	Owner's Insurance	-	-	-	-	-	-	-	-	-
2	Permits		-	-	-	-	-	-	-	-
3	Printing		-	-	-	-	-	-	-	-
4	Construction Utilities Use		-	-	-	-	-	-	-	-
5	Site Borings		-	-	-	-	-	-	-	-
6	Materials Testing	5.0	-	5.0	-	-	-	5.0	5.0	-
7	Special Inspections		-	-	-	-	-	-	-	-
8	Consultant Reimbursables		-	-	-	-	-	-	-	-
9	Moving/Relocation		-	-	-	-	-	-	-	-
10	Physical Plant Expenses		-	-	-	-	-	-	-	-
11	Misc. Expenses		-	-	-	-	-	-	-	-
12	Advertising		-	-	1.5	-	1.5	-	1.5	(1.5)
13	Temporary Space/Ops		-	-	-	-	-	-	-	-
14	Bond/Financing		-	-	-	-	-	-	-	-
15	Site Acquisition		-	-	-	-	-	-	-	-
	Sub-total Expenses	5.0	-	5.0	1.5	-	1.5	5.0	6.5	(1.5)
	Total Fees and Expenses	379.6	-	379.6	212.6	179.1	391.7	5.0	396.7	(17.1)
VI.	**Contingency**									
A.	Construction & Owner's Project									
1	Construction	371.9	200.5	572.4	-	-	-	58.3	58.3	514.1
2	Owner's Project	-	-	-	-	-	-	-	-	-
B.	Additional Need	-	-	-	-	-	-	-	-	-
	Total Contingency	371.9	200.5	572.4	-	-	-	58.3	58.3	514.1
	Total Project	$ 3,475.0	$ -	$ 3,475.0	$ 1,493.3	$ 1,375.6	$ 2,868.9	$ 113.3	$ 2,982.2	$ 492.8

TOWN OF LEDYARD

741 Colonel Ledyard Highway
Ledyard, CT 06339-1511

File #: 25-2436 **Agenda Date:** 9/8/2025 **Agenda #:** 3.

FINANCIAL BUSINESS REQUEST (FBR)

Motion/Request:
MOTION to approve Collier Project Leaders Inv #0001078589 dated 7.31.2025 in the amount of $5,430.00 for Project 24012605G OPM-Juliet Long HVAC Installation.

Background:
(type text here)

Department Comment/Recommendation:
(type text here)

Finance Director Comment/Recommendation:
(type text here)

Mayor Comment/Recommendation:
(type text here)

Colliers Project Leaders
A Division of Colliers Engineering & Design

101 Crawfords Corner Road, Suite 3400
Holmdel, NJ 07733
732 383 1950

Ledyard CT, Town of
Attn: Matthew Bonin
741 Colonel Ledyard Highway
Ledyard, CT 06339

Invoice : 0001078589
Invoice Date : 7/31/2025

Project : 24012605G
Project Manager: Warrington, Jr., Chuck
Project Name : OPM-Juliet Long HVAC Installation

For Professional Services Rendered Through 7/31/2025

Description of Services:
July 2025
1. Site visits and observations
2. Attend weekly OAC meetings
3. Draft field reports
4. Draft project budget and reconcile against town ledger
5. Review bid documents and addenda
6. Internal staff meetings
7. Meeting with mayor, BC chair, town director of finance and BOE director of facilities
8. Obtain quotes from Materials Testing Lab.

	Fee	Remaining Fee	% Complete	Billings To Date	Billings Previous	Billings Current
Construction Phase	75,000.00	69,570.00	7.24	5,430.00	0.00	5,430.00
Procurement Phase	25,000.00	25,000.00	0.00	0.00	0.00	0.00
OGA Closeout	10,000.00	10,000.00	0.00	0.00	0.00	0.00
Reimbursable Expenses	5,000.00	5,000.00	0.00	0.00	0.00	0.00
Subtotal:	115,000.00	109,570.00	4.72	5,430.00	0.00	5,430.00

Current Billings	5,430.00
Amount Due This Bill	5,430.00

finance.director@ledyardct.org;
charles.warrington@collierseng.com

In accordance with our business terms and conditions, acceptance of this invoice is implied unless Colliers Project Leaders USA NE, LLC is notified by 14 days from the date of this invoice.
If timely payment cannot be made due to any discrepancy, please E-mail a brief explanation to Billing@colliersengineering.com and we will reply as soon as possible.
EFT/ACH PAYMENT INFO: Colliers Engineering & Design, Inc. | JP Morgan Chase | Routing 021000021 | Account# 836759092

PM05 - Construction Phase

Labor

Rate Labor

Class	*Hours*	*Rate*	*Amount*
Assistant Project Manager	6.00	110.0000	660.00
Director	10.00	290.0000	2,900.00
Senior Construction Representative	11.00	170.0000	1,870.00
Total Rate Labor			***5,430.00***
Total Labor			**5,430.00**
Total Bill Task: PM05 - Construction Phase			**5,430.00**

Total Project: 24012605G - OPM-Juliet Long HVAC Installation **5,430.00**

TOWN OF LEDYARD

741 Colonel Ledyard Highway
Ledyard, CT 06339-1511

File #: 25-2454 **Agenda Date:** 9/9/2025 **Agenda #:** 4.

FINANCIAL BUSINESS REQUEST (FBR)

Motion/Request:
MOTION to approve Colliers Project Inv #0001088123 dated 8.31.2025 in the amount of $10,844.90 for Project 24012605G OPM-Juliet Long HVAC Installation.

Background:
(type text here)

Department Comment/Recommendation:
(type text here)

Finance Director Comment/Recommendation:
(type text here)

Mayor Comment/Recommendation:
(type text here)

Colliers Project Leaders

A Division of Colliers Engineering & Design

101 Crawfords Corner Road, Suite 3400
Holmdel, NJ 07733
732 383 1950

Ledyard CT, Town of
Attn: Matthew Bonin
741 Colonel Ledyard Highway
Ledyard, CT 06339

Invoice : 0001088123
Invoice Date : 8/31/2025

Project : 24012605G
Project Manager: Warrington, Jr., Chuck
Project Name : OPM-Juliet Long HVAC Installation

For Professional Services Rendered Through 8/31/2025

Description of Services:
August 2025
1. Site walkthroughs
2. Attend PMBC meeting
3. Update financials
4. Review ceiling quotes and compare against square footage required.
5. Draft field reports
6. Markup of mechanical drawings with completed work above ceiling.
7. Update commissioning RFP.
8. Review responses to RFI's
9. Review of school status prior to school opening.
10. Inquire with project team on as-builts.

					Billings		
	Fee	Remaining Fee	% Complete	To Date	Previous	Current
Construction Phase	75,000.00	60,027.50	19.96	14,972.50	5,430.00	9,542.50
Procurement Phase	25,000.00	24,420.00	2.32	580.00	0.00	580.00
OGA Closeout	10,000.00	10,000.00	0.00	0.00	0.00	0.00
Reimbursable Expenses	5,000.00	4,277.60	14.45	722.40	0.00	722.40
Subtotal:	115,000.00	98,725.10	14.15	16,274.90	5,430.00	10,844.90

Current Billings	10,844.90
Amount Due This Bill	10,844.90

finance.director@ledyardct.org;
charles.warrington@collierseng.com

Outstanding Receivables

Invoice Number	Date	Amount	Balance Due
0001078589	7/31/2025	5,430.00	5,430.00
			5,430.00

In accordance with our business terms and conditions, acceptance of this invoice is implied unless Colliers Project Leaders USA NE, LLC is notified by 14 days from the date of this invoice. If timely payment cannot be made due to any discrepancy, please E-mail a brief explanation to Billing@colliersengineering.com and we will reply as soon as possible.
EFT/ACH PAYMENT INFO: Colliers Engineering & Design, Inc. | JP Morgan Chase | Routing 021000021 | Account# 836759092

PM05 - Construction Phase

Labor
Rate Labor

Class	*Hours*	*Rate*	*Amount*
Assistant Project Manager	36.00	110.0000	3,960.00
Director	15.00	290.0000	4,350.00
Senior Construction Representative	7.25	170.0000	1,232.50
Total Rate Labor			***9,542.50***
Total Labor			**9,542.50**
Total Bill Task: PM05 - Construction Phase			**9,542.50**

PM09 - Procurement Phase

Labor
Rate Labor

Class	*Hours*	*Rate*	*Amount*
Director	2.00	290.0000	580.00
Total Rate Labor			***580.00***
Total Labor			**580.00**

ZREIMB - Reimbursable Expenses

Expense
Unit Rate Expenses

Account / Unit	*Amount*
Project Mileage	
Mileage	722.40
Total Project Mileage	722.40
Total Unit Rate Expenses	***722.40***
Total Expense	**722.40**
Total Bill Task: ZREIMB - Reimbursable Expenses	**722.40**

Total Project: 24012605G - OPM-Juliet Long HVAC Installation **10,844.90**

File #: 25-2450 **Agenda Date:** 9/8/2025 **Agenda #:** 5.

FINANCIAL BUSINESS REQUEST (FBR)

Motion/Request:
MOTION to approve Kamco Supply Corp of New England Inv #2507-066308 dated 7.22.2025 in the amount of $1,298.00 for Order #2507-E64543 JWL-HVAC Project.

Background:
(type text here)

Department Comment/Recommendation:
(type text here)

Finance Director Comment/Recommendation:
(type text here)

Mayor Comment/Recommendation:
(type text here)

BUILDING THE FUTURE - TOGETHER

Kamco
SUPPLY CORP OF NEW ENGLAND

East Hartford
Kamco Supply Corp of NE
181 Burnham Street
East Hartford CT 06108
860-282-0156
Fax: 860-291-8217

CUSTOMER COPY

INVOICE

2507-066308 PAGE 1 OF 1

ACCOUNT	JOB
17861	0
SOLD ON	7/22/2025 12:54:49 PM
DELIVER ON	7/22/2025
BRANCH	EH
CUSTOMER PO#	
STATION	EHBO
CASHIER	EHBO
SALESPERSON	CR1
ORDER ENTRY	EHLG

SOLD TO

Ledyard Public Schools
4 Blonders Boulevard
Ledyard CT 06339

DELIVER

Ledyard Public Schools
1854 CT-12, Gales Ferry, CT
Ledyard CT 06339
860-464-9255

NO BOOM NEEDED

We install Commercial Door &
Div 10 Specialties Packages.
Contact Kamco for a quote.

Quantity	UM	Item	Description	D	T	Price	Per	Amount
			Order: 2507-E64543					
40	EA	358X10-20	3-5/8"x10' Stud 20GA/EQ		Y	0.5800	LFT	232.00
80	EA	358TR20	3-5/8"x10' Track 20GA/EQ		Y	0.5800	LFT	464.00
30	EA	12REG10	1/2"4x10 LITE REG Gypsum Drywall		Y	0.4600	SQFT	552.00
1	EACH	DELIVERY	DELIVERY CHARGE		Y	50.0000	EACH	50.00
1	EA	COMMENT	no boom needed				EA	

8/12/25

Authorized to Pay

Payment Method(s)

Charge to Acct 1,298.00

Signature

PO# Date

	SubTotal	1,298 00
CT-GOV 0.00% EXE: X	Sales Tax	0 00
	Deposit	
Please Pay This Amount		1,298.00

Remit To: PO Box 530 ,Wallingford, CT 06492
Deduct 1% of the SubTotal if paid by the 10th of next month. Avoid a 1.5% finance charge by paying invoice in full by end of following month.
+No refund or credit for non-stock material.

Signature

File #: 25-2437 **Agenda Date:** 9/8/2025 **Agenda #:** 6.

FINANCIAL BUSINESS REQUEST (FBR)

Motion/Request:
MOTION to approve Kamco Supply Corp of New England Inv #2507-072778 dated 7.29.2025 in the amount of $406.00 for Order #2507-E71735 JWL-HVAC Project.

Background:
(type text here)

Department Comment/Recommendation:
(type text here)

Finance Director Comment/Recommendation:
(type text here)

Mayor Comment/Recommendation:
(type text here)

BUILDING THE FUTURE - TOGETHER

Kamco
SUPPLY CORP OF NEW ENGLAND

East Hartford
Kamco Supply Corp of NE
181 Burnham Street
East Hartford CT 06108
860-282-0156
Fax: 860-291-8217

CUSTOMER COPY

INVOICE

2507-072778 PAGE 1 OF 1

ACCOUNT	JOB
17861	0
SOLD ON	7/29/2025 8:42:06 PM
CUST PICKUP	
BRANCH	EH
CUSTOMER PO#	DONALDSON CALL IN
STATION	EHRH
CASHIER	EHRH
SALESPERSON	CR1
ORDER ENTRY	EH1

SOLD TO

Ledyard Public Schools
4 Blonders Boulevard
Ledyard CT 06339

DELIVER

Ledyard Public Schools
4 Blonders Boulevard
Ledyard CT 06339
860-464-9255

CERT 134

We install Commercial Door &
Div 10 Specialties Packages.
Contact Kamco for a quote.

Quantity	UM	Item	Description	D	T	Price	Per	Amount
			Order: 2507-E71735					
70	EA	358TR20	3-5/8"x10' Track 20GA/EQ		Y	0.5800	LFT	406.00

8/12/25

Authorized to Pay

Payment Method(s)

Signature

Charge to Acct 406.00

PO# _____ Date _____

CT-GOV 0.00% EXE: X	SubTotal	406.00
	Sales Tax	0.00
	Deposit	
Please Pay This Amount		406.00

Remit To: PO Box 530 ,Wallingford, CT 06492
Deduct 1% of the SubTotal if paid by the 10th of next month. Avoid a 1.5% finance charge by paying invoice in full by end of following month.
+No refund or credit for non-stock material.

Signature

TOWN OF LEDYARD

741 Colonel Ledyard Highway
Ledyard, CT 06339-1511

File #: 25-2447 **Agenda Date:** 9/8/2025 **Agenda #:** 7.

FINANCIAL BUSINESS REQUEST (FBR)

Motion/Request:
MOTION to approve Kamco Supply Corp of New England Inv #2508-099062 dated 8.28.2025 in the amount of $58.00 for Order: 2508-E90923 JWL - HVAC Project.

Background:
(type text here)

Department Comment/Recommendation:
(type text here)

Finance Director Comment/Recommendation:
(type text here)

Mayor Comment/Recommendation:
(type text here)

BUILDING THE FUTURE - TOGETHER

Kamco
SUPPLY CORP OF NEW ENGLAND

East Hartford
Kamco Supply Corp of NE
181 Burnham Street
East Hartford CT 06108
860-282-0156
Fax: 860-291-8217

CUSTOMER COPY

INVOICE

2508-099062 PAGE 1 OF 1

ACCOUNT	JOB
17861	0
SOLD ON	8/28/2025 3:42:21 PM
CUST PICKUP	
BRANCH	EH
CUSTOMER PO#	
STATION	EHBO
CASHIER	EHBO
SALESPERSON	CR1
ORDER ENTRY	EHTB

SOLD TO

Ledyard Public Schools
4 Blonders Boulevard
Ledyard CT 06339

DELIVER

Ledyard Public Schools
4 Blonders Boulevard
Ledyard CT 06339
860-464-9255

CERT 134

We install Commercial Door &
Div 10 Specialties Packages.
Contact Kamco for a quote.

Quantity	UM	Item	Description	D	T	Price	Per	Amount
			Order: 2508-E90923					
10	EA	358TR20	3-5/8"x10' Track 20GA/EQ		Y	0.5800	LFT	58.00

Payment Method(s)

Charge to Acct 58.00

CT-GOV 0.00% EXE: X	SubTotal	58.00
	Sales Tax	0.00
	Deposit	
Please Pay This Amount		58.00

Remit To: PO Box 530 ,Wallingford, CT 06492
Deduct 1% of the SubTotal if paid by the 10th of next month. Avoid a 1.5% finance charge by paying invoice in full by end of following month.
+No refund or credit for non-stock material.

Signature

File #: 25-2435 **Agenda Date:** 9/8/2025 **Agenda #:** 8.

FINANCIAL BUSINESS REQUEST (FBR)

Motion/Request:
MOTION to approve The Nutmeg Companies, Inc. Application for Payment dated 8.27.2025 in the amount of $485,496.55 for Project 2503 Juliet W. Long Elementary School HVAC Replacement.

Background:
(type text here)

Department Comment/Recommendation:
(type text here)

Finance Director Comment/Recommendation:
(type text here)

Mayor Comment/Recommendation:
(type text here)

TO OWNER: Town of Ledyard
741 Colonel Ledyard Highway
Ledyard, CT 06339-1511

PROJECT : Juliet W. Long School-HVAC Project
1854 CT-12
Gales Ferry, CT 06335

APPLICATION NO : 2
PERIOD TO : 8/31/2025
PROJECT NO : 2503
CONTRACT DATE : 7/9/2025
GRANT NO :
TASK ORDER NO:
PDN NO:
REQUISITION REF#:
TIN: 06-1236809

Distribution to :
OWNER **Town of Ledyard**
ARCHITECT **Friar Architecture Inc.**
CONTRACTOR **The Nutmeg Companies Inc.**

FROM CONTRACTOR :
The Nutmeg Companies, Inc.
1 Ohio Ave., Norwich, CT 06360
ATTN: Mike Gawendo-Project Manager mgawendo@nutmegcompanies.com
CONTRACT FOR: Juliet W. Long Elementary Schoole HVAC Replacement

CONTRACTOR'S APPLICATION FOR PAYMENT
Application is made for payment, as shown below, in connection with the Contract.
Continuation Sheet, AIA Document G703, is attached.

1.	**ORIGINAL CONTRACT SUM**		$2,673,520.00
2.	**Net Change by Change Orders**		-$200,514.00
3.	**CONTRACT SUM TO DATE** (Line 1 + 2)		$2,473,006.00
4.	**TOTAL COMPLETED & STORED TO DATE** (Column G on G703)		$1,343,706.00
5.	**RETAINAGE :**		
	a. 5 % of Completed Work (Columns D + E on G703)	$67,185.30	
	b. 5 % of Stored Material (Column F on G703)	$0.00	
	Total Retainage (Line 5a + 5b or Total in Column I of G703)		$67,185.30
6.	**TOTAL EARNED LESS RETAINAGE** (Line 4 less Line 5 Total)		$1,276,520.70
7.	**LESS PREVIOUS CERTIFICATES FOR PAYMENT** (Line 6 from prior Certificate)		$791,024.15
8.	**CURRENT PAYMENT DUE**		$485,496.55
9.	**BALANCE TO FINISH, INCLUDING RETAINAGE** (Line 3 less Line 6)	$1,196,485.30	

CHANGE ORDER SUMMARY	ADDITIONS	DEDUCTIONS
Total Changes approved in previous months by Owner		
Total approved this Month	-	(200,514.00)
TOTAL		(200,514.00)
NET CHANGES by Change Order	(200,514.00)	

The undersigned Contractor certifies that to the best of the Contractor's knowledge, information and belief the Work covered by this Application for Payment has been completed in accordance with the Contract Documents, that all amounts have been paid by the Contractor for Work for which previous Certificates for Payment were issued and payments received from the Owner , and that current payment shown herein is now due.

CONTRACTOR: The Nutmeg Companies, Inc.

By Tammy Magrey Date : August 27, 2025
Tammy Magrey- CFO

State of : Connecticut
County of : New London
Subscribed and sworn to before me this 27th day of August 2025

Notary Public:
My Commission expires : 8/31/2025

ARCHTECT'S CERTIFICATE FOR PAYMENT

In accordance with the Contract Documents, based on on-site observations and the data comprising this application, the Architect certifies to the Owner that to the best of the Architect's knowledge, information and belief the Work has progressed as indicated, the quality of the Work is in accordance with the Contract Documents, and the Contractor is entitled to payment of the AMOUNT CERTIFIED.

AMOUNT CERTIFIED.....$ 485,496.55

(Attach explanation if amount certified differs from the amount applied for Initial all figures on this Application and on the Continuation Sheet that are changed to conform to the amount certified).

ARCHITECT:
By : Scott W Mitchell Date : 8/29/2025

This certificate is not negotiable. The AMOUNT CERTIFIED is payable only to the contractor named herein.Issuance,payment and acceptance of payment are without prejudice to any rights of the Owner or Contractor under this Contract.

CONTINUATION SHEET

AIA DOCUMENT G703

AIA Document G702, APPLICATION AND CERTIFICATION FOR PAYMENT, containing
Contractor's signed certification is attached.
In tabulations below, amounts are stated to the nearest dollar.
Use Column I on Contracts where variable retainage for line items may apply.

Days added by Modification

APPLICATION NO: 2
APPLICATION DATE: 31-Aug-25
PERIOD TO: 31-Aug-25
CONTRACT NO: 2503
TASK ORDER: 0

A	B	C	D	E	F	G		H
ITEM NO.	DESCRIPTION OF WORK	SCHEDULED VALUE	WORK COMPLETED FROM PREVIOUS APPLICATION (D+E)	WORK COMPLETED THIS PERIOD	MATERIALS PRESENTLY STORED	TOTAL COMPLETED AND STORED TO DATE (D+E+F)	% (G ÷ C)	BALANCE TO FINISH (C - G)
1								
2								
3	**DIVISION-1 GENERAL REQUIREMENTS**							
4	BOND	11,957.00	11,957.00	-	-	11,957.00	100%	-
5	MOBILIZATION	15,000.00	15,000.00	-	-	15,000.00	100%	-
6	ALLOWANCE NO. 1 - CONSTRUCTION MANAGERS ALLOWANCE	200,514.00	-	200,514.00	-	200,514.00	100%	-
7	ALLOWANCE NO. 2 - TOP OF WALL SMOKE SAFING	11,500.00	-	-	-	-	0%	11,500.00
8	ALLOWANCE NO. 3 - SMOKE SAFE EXISTING PENETRATIONS	4,300.00	-	-	-	-	0%	4,300.00
9	ALLOWANCE NO. 4 - SMOKE SEAL AROUND EXISTING ITEMS	8,600.00	-	-	-	-	0%	8,600.00
10	AS-BUILT SUBMISSION	3,334.00	-	-	-	-	0%	3,334.00
11	O&M SUBMISSION	3,333.00	-	-	-	-	0%	3,333.00
12	WARRANTEE SUBMISSION	3,333.00	-	-	-	-	0%	3,333.00
13	COMMISSIONING SUPPORT	3,500.00	-	-	-	-	0%	3,500.00
	TRAINING	1,500.00	-	-	-	-	0%	1,500.00
14								
15	**DIVISION-2 EXISTING CONDITIONS**							
16	SAWCUTTING DUCT HOLES-LABOR	35,000.00	34,000.00	1,000.00	-	35,000.00	100%	-
17	CORE BORE REFER/CONDENSATE LINES-LABOR	35,000.00	35,000.00	-	-	35,000.00	100%	-
18								
19	**DIVISION-5 METALS**							
20	STRUCTURAL STEEL-SHOP DRAWINGS	5,000.00	5,000.00	-	-	5,000.00	100%	-
21	STRUCTURAL STEEL-MATERIAL	25,000.00	24,000.00	1,000.00	-	25,000.00	100%	-
22	STRUCTURAL STEEL-LABOR	25,000.00	23,700.00	1,300.00	-	25,000.00	100%	-
23								
24	**DIVISION-6 WOOD, PLASTICS AND COMPOSITES**							
25	ROUGH CARPENTRY-MATERIAL	5,000.00	-	1,500.00	-	1,500.00	30%	3,500.00
26	ROUGH CARPENTRY-LABOR	5,000.00	-	1,500.00	-	1,500.00	30%	3,500.00
27								
28	**DIVISION-7 ROOFING**							
29	ROOFING-MATERIAL	100,000.00	-	19,000.00	-	19,000.00	19%	81,000.00
30	ROOFING-LABOR	125,000.00	-	18,000.00	-	18,000.00	14%	107,000.00
31								
32	**DIVISION 23-HVAC**							
33	MECHANICAL DEMO	17,000.00	9,000.00	-	-	9,000.00	53%	8,000.00
34	TESTING, ADJUSTING, BALANCING	7,800.00	-	-	-	-	0%	7,800.00
35	HVAC INSULATION-MATERIAL	45,000.00	15,000.00	10,000.00	-	25,000.00	56%	20,000.00
36	HVAC INSULATION-LABOR	45,000.00	6,000.00	18,000.00	-	24,000.00	53%	21,000.00
37	BUILDING CONTROLS WIRING ROUGH-IN MATERIAL	38,800.00	-	-	-	-	0%	38,800.00

CONTINUATION SHEET

AIA DOCUMENT G703

AIA Document G702, APPLICATION AND CERTIFICATION FOR PAYMENT, containing
Contractor's signed certification is attached.
In tabulations below, amounts are stated to the nearest dollar.
Use Column I on Contracts where variable retainage for line items may apply.

Days added by Modification

APPLICATION NO: 2
APPLICATION DATE: 31-Aug-25
PERIOD TO: 31-Aug-25
CONTRACT NO: 2503
TASK ORDER: 0

A	B	C	D	E	F	G		H
ITEM NO.	DESCRIPTION OF WORK	SCHEDULED VALUE	WORK COMPLETED FROM PREVIOUS APPLICATION (D+E)	WORK COMPLETED THIS PERIOD	MATERIALS PRESENTLY STORED	TOTAL COMPLETED AND STORED TO DATE (D+E+F)	% (G ÷ C)	BALANCE TO FINISH (C - G)
38	BUILDING CONTROLS - VALVES	35,000.00	-	-	-	-	0%	35,000.00
39	BUILDING CONTROLS WIRING ROUGH-IN LABOR	40,000.00	-	-	-	-	0%	40,000.00
40	BUILDING CONTROS - VALVE INSTALLATION	15,000.00	-	-	-	-	0%	15,000.00
41	BUILDING CONTROLS - PROGRAMING / START-UP	10,000.00	-	-	-	-	0%	10,000.00
42	VRF TEMPERATURE CONTROLS ENGINEERING/SUBMITTALS	10,000.00	-	2,500.00	-	2,500.00	25%	7,500.00
43	VRF TEMPERATURE CONTROLS ROUGH-IN-MATERIAL	45,000.00	20,000.00	25,000.00	-	45,000.00	100%	-
44	VRF TEMPERATURE CONTROLS ROUGH-IN-LABOR	45,000.00	-	40,000.00	-	40,000.00	89%	5,000.00
45	VRF TEMPERATURE CONTROLS-PROGRAMMING	15,000.00	-	-	-	-	0%	15,000.00
46	VRF UNITS-MATERIAL	120,000.00	120,000.00		-	120,000.00	100%	-
47	VRF UNITS-LABOR	55,000.00	16,000.00	39,000.00	-	55,000.00	100%	-
48	VRF #9	37,000.00	6,000.00	25,000.00	-	31,000.00	84%	6,000.00
49	VRF CONDENSING UNITS-MATERIAL	80,000.00	60,000.00	20,000.00	-	80,000.00	100%	-
50	VRF CONDENSING UNITS-LABOR	19,000.00	-	-	-	-	0%	19,000.00
51	DOA/RTU 1 CURBS-MATERIAL	18,000.00	-	-	-	-	0%	18,000.00
52	DOA/RTU 1 CURBS-LABOR	15,000.00	-	-	-	-	0%	15,000.00
53	DOA MATERIAL	211,000.00	-	-	-	-	0%	211,000.00
54	DOA LABOR	20,000.00	-	-	-	-	0%	20,000.00
55	RTU MATERIAL	111,500.00	-	40,000.00	-	40,000.00	36%	71,500.00
56	RTU LABOR	8,300.00	-	-	-	-	0%	8,300.00
57	PIPE HANGERS-MATERIAL	35,000.00	30,000.00	3,000.00	-	33,000.00	94%	2,000.00
58	PIPE HANGERS-LABOR	45,000.00	38,000.00	3,000.00	-	41,000.00	91%	4,000.00
59	REFRIGERANT PIPING-MATERIAL	125,000.00	100,000.00	24,000.00	-	124,000.00	99%	1,000.00
60	REFRIGERANT PIPING-LABOR	125,000.00	40,000.00	75,000.00	-	115,000.00	92%	10,000.00
61	DUCTWORK SHOP DRAWINGS	10,000.00	-	10,000.00	-	10,000.00	100%	-
62	DUCT ROOF RAILS/STANDS-MATERIAL	20,000.00	-	-	-	-	0%	20,000.00
63	DUCT ROOF RAILS/STANDS-LABOR	20,000.00	-	-	-	-	0%	20,000.00
64	OA INTERIOR DUCTWORK-MATERIAL	80,000.00	72,000.00	8,000.00	-	80,000.00	100%	-
65	OA INTERIOR DUCTWORK-LABOR	80,749.00	72,000.00	8,749.00	-	80,749.00	100%	-
66	DUCTWORK FOR VRF-MATERIAL	76,000.00	30,000.00	46,000.00	-	76,000.00	100%	-
67	DCUTWORK FOR VRF-LABOR	76,000.00	30,000.00	42,000.00	-	72,000.00	95%	4,000.00
68	DUCTWORK ROOF-MATERIAL	50,000.00	-	-	-	-	0%	50,000.00
69	DUCTWORK ROOF-LABOR	48,500.00	-	-	-	-	0%	48,500.00
70	DUCTWORK RTU-2 MATERIAL	10,000.00	-	-	-	-	0%	10,000.00
71	DUCTWORK RTU-2 LABOR	10,000.00	-	-	-	-	0%	10,000.00
72								
73	**DIVISION 26 - ELECTRICAL**							
74	ELECTRICAL DEMO/DISCONNECT-LABOR	10,000.00	-	2,000.00	-	2,000.00	20%	8,000.00
75	CONDUIT-MATERIAL	20,000.00	10,000.00	1,500.00	-	11,500.00	58%	8,500.00

CONTINUATION SHEET

AIA DOCUMENT G703

AIA Document G702, APPLICATION AND CERTIFICATION FOR PAYMENT, containing
Contractor's signed certification is attached.
In tabulations below, amounts are stated to the nearest dollar.
Use Column I on Contracts where variable retainage for line items may apply.

Days added by Modification

APPLICATION NO: 2
APPLICATION DATE: 31-Aug-25
PERIOD TO: 31-Aug-25
CONTRACT NO: 2503
TASK ORDER: 0

A	B	C	D	E	F	G		H
ITEM NO.	DESCRIPTION OF WORK	SCHEDULED VALUE	WORK COMPLETED FROM PREVIOUS APPLICATION (D+E)	WORK COMPLETED THIS PERIOD	MATERIALS PRESENTLY STORED	TOTAL COMPLETED AND STORED TO DATE (D+E+F)	% (G ÷ C)	BALANCE TO FINISH (C - G)
76	CONDUIT-LABOR	30,000.00	10,000.00	5,000.00		15,000.00	50%	15,000.00
77	POWER WIRING-MATERIAL	40,000.00	-	12,000.00	-	12,000.00	30%	28,000.00
78	POWER WIRING-LABOR	30,000.00	-	8,000.00	-	8,000.00	27%	22,000.00
79	PANELBOARD-MATERIAL	30,000.00	-	-	-	-	0%	30,000.00
80	PANELBOARD-LABOR	10,000.00	-	-	-	-	0%	10,000.00
81								
82	**DIVISION 28-ELECTRONIC SAFETY AND SECURITY**							
83	DUCT SMOKES-MATERIAL	1,000.00	-	-	-	-	0%	1,000.00
84	DUCT SMOKES-LABOR	1,000.00	-	-	-	-	0%	1,000.00
85								
86	TOTAL	2,673,520.00	832,657.00	711,563.00	-	1,544,220.00	58%	1,129,300.00
87								
88	CHANGE ORDERS							
89	CO#1 - Deduct Construction Managers Allowance	(200,514.00)	-	(200,514.00)	-	(200,514.00)	100%	-
90								
91								
92								
93								
94	TOTAL CHANGE ORDERS	(200,514.00)	-	(200,514.00)	-	(200,514.00)	0%	-
95								
96								
97	GRAND TOTALS	2,473,006.00	832,657.00	511,049.00	-	1,343,706.00	54%	1,129,300.00

File #: 25-2448 **Agenda Date:** 9/8/2025 **Agenda #:** 9.

AGENDA REQUEST
GENERAL DISCUSSION ITEM

Subject:
Approval of RFP for Commissioning Agent services.

Background:
(type text here)

Department Comment/Recommendation:
(type text here)

File #: 25-1866 **Agenda Date:** 9/8/2025 **Agenda #:** 1.

AGENDA REQUEST
GENERAL DISCUSSION ITEM

Subject:
Any Old Business proper to come before the Committee

Background:
(type text here)

Department Comment/Recommendation:
(type text here)

File #: 25-1260 **Agenda Date:** 9/8/2025 **Agenda #:** 1.

AGENDA REQUEST
GENERAL DISCUSSION ITEM

Subject:
Any New Business proper to come before the Committee

Background:
(type text here)

Department Comment/Recommendation:
(type text here)