

ADDENDUM #1

To Drawings and Specifications for

**Elevator Modernization for
Springbrook High School**

Montgomery County Public Schools

07 October 2026

INTRODUCTION:

This Addendum is issued for the purpose of amending the requirements of the drawings and specifications dated June 12, 2026, and is made part of the Bidding Documents to the same extent as though it was included therein.

PREVIOUS ADDENDA:

None

INDEX:

- A. GENERAL INFORMATION
- B. PRE-BID RFI QUESTIONS & ANSWERS
- C. ARCHITECTURAL DRAWINGS
- D. MEP DRAWINGS

A. GENERAL INFORMATION

None

B. PRE-BID RFI QUESTIONS & ANSWERS

RFI #1

Question 1: Please confirm that this project is not subject to prevailing wages.

Response: No prevailing wages.

Question 2: Due to the project being scheduled to be completed during the summer break of 2027, please confirm whether MCPS will allow for additional material escalation costs beyond the contractor's control once the equipment is ordered in spring of 2027 (if applicable).

Response: No escalation.



Question 3: Is full time on-site supervision required from the prime contractor or will it be acceptable for the elevator contractor's foreman to act as the supervisor when only elevator-specific work is taking place?

- a. If not, please confirm that the general contractor awarded the project will be required to have a full-time on-site superintendent throughout the duration of the construction phase.

Response: There should be a lead person on site who is responsible for on-going work on the site.

Question 4: Please confirm if the new elevator machine room mechanical equipment and the new elevator pit sump pump will be required to be integrated into the building automation system (BAS)? If so, please provide the main point of contact for the incumbent BAS provider. **Response: Yes, the Sump Pumps shall be integrated into the Facility Security System. Contractor shall provide and install 18/4 Bell Wire from Elevator pit to Room C-203; provide, program and integrate high water sensor in the sump pump pit with the Security System.**

Contractor shall contact MCPS Electronic Shop @ 240 740 2515 to schedule programming of the device

Question 5: Please confirm that the contractor is responsible for the new card reader devices for each elevator.

Response: Yes.

Question 6: Please confirm the contractor is responsible for running new network cabling to the elevator machine room to meet code requirements for the elevator cab two-way communications system.

Response: Yes, bid as specified.

Question 7: Please confirm if damp-proofing of the elevator pit floors and walls be required for this project?

Response: Damp-proofing is not required in elevator pit.

Question 8: Please confirm only one sump pump is required to be installed for this project (SP-1) and that there is no SP-2 to install as implied by keynote 1 on drawing MP1.1.

Response: Correct.

Question 9: Please confirm that the Maryland Buy American Steel Act does not apply to this project.

Response: Follow all State laws when applicable.

Question 10: Please confirm that all work on site will occur during normal working hours.

Response: Contractors can request additional hours.

Question 11: It is our understanding that the 2022 edition of ASME 17.1 elevator code is now in effect. Please confirm that the contractor is responsible for the additional code-related work not



shown on the drawings such as retractable weight actuated elevator pit ladders, etc. Please confirm this project should meet the ASME A17.1 2022 Code requirements.

Response: Yes, the Contractor is responsible for ensuring the work conforms to current code requirements.

Question 12: Please confirm elevator warranty is for two years.

Response: Yes, bid as specified.

Question 13: Please confirm that any hazardous materials abatement will not be the responsibility of the contractor if encountered. It was noted on the site visit that the existing ceiling have asbestos. Please confirm MCPS will handle all abatement.

Response: Correct.

Question 14: Please confirm if an interior staging area will be provided.

Response: Yes.

Question 15: Please provide the point of contact information for the incumbent fire alarm servicer/company at the facility.

Response: Contact MCPS fire alarm contractors for service: TAN Fire Alarms; Convergint; EAI.

Question 16: Section 01 10 00- Part 1 General - 1.1. Summary -D.5 mentions fire alarm as new work. Please clarify the fire alarm scope (if any). Fire Alarm work is not identified on the drawing E1.1. If so, please specify and confirm it is the responsibility of the contractor. It was also observed at the site visit that new devices exist.

Response: Existing fire alarm devices to remain. However, the Contractor is responsible for ensuring the system is functional conforms to current code requirements. This includes providing any new devices required by code/inspector and/or replacement of existing defective devices.

Question 17: Please confirm if the offeror will be required to obtain and pay for a building permit?

Response: MCPS will apply for building permit, but contractor is responsible for permit payments.

Question 18: Please confirm that Builder's Risk insurance is not required for this project.

Response: See Insurance section of the bid documents.

Question 19: Are 8' temporary hard plywood barricades required to be constructed at each elevator entrance during the execution of the elevator modernizations to separate the staff and students from the work areas?

Response: Contractor is responsible for securing work area.

Question 20: Please confirm if facility's restrooms can be used by on-site workers during construction.

Response: Yes.



Question 21: Please confirm if on site workers have free parking during construction.

Response: Yes.

Question 22: Section 01 10 00- Part 1 General - 1.1. Summary -D.5 mentions modifying the existing built-up asphalt roofing and metal deck for installation of a new rooftop split system HVAC. Please confirm the condensing unit location as the drawings indicate the outdoor unit will be wall mounted at grade. If roof-mounted, please issue the structural reinforcement and roof curb/penetration details, identify the existing roofing manufacturer and warranty, and provide the list of MCPS-approved roofers.

Response: Roof work is not required for this project.

Question 23: Please indicate if the existing roof is under warranty and if so, please indicate the roofing subcontractor who holds the warranty.

Response: Not Applicable.

Question 24: Section 01 10 00- Part 1 General - 1.1. Summary -D.5 mentions sprinkler systems as new work. Please clarify the sprinkler scope (if any). Sprinkler work is not identified on the drawings. If so, please specify and confirm it is the responsibility of the contractor.

Response: As noted on A0.1, the scope of sprinkler work is expected to be limited to adjusting head locations and adding heads where necessary to comply with code requirements. The Contractor is responsible for ensuring the work conforms to current code requirements.

Question 25: For the elevator, please confirm that the contractor is required to install a new OS&Y sprinkler valve to isolate the elevator pit and machine room to meet current code requirements.

Response: Yes, the Contractor is responsible for ensuring the work conforms to current code requirements.

Question 26: Please consider extending the bid due date 1-2 weeks from the date that the RFI responses are provided.

Response: See erratum for bid date.

Question 27: Please confirm if the MCPS Office is open on October 12, 2026 - Columbus Day (bid due date).

Response: See erratum for bid date.

Question 28: Please confirm that MBE Forms D-3A and D-3B are to be submitted within 10 days of notification of apparent award.

Response: Please complete MBE form as required.

Question 29: Please clarify if the contractor is required to include a 1% DGS fee in our total bid price.

Response: Yes, bid as specified.



Question 30: 01 45 00 - Quality Control. Please confirm testing and inspections are only required for applicable work affected by the scope of this contract.

Response: Yes, bid as specified.

Question 31: Please confirm that the elevator does not currently operate on emergency generator power.

Response: Correct.

Question 32: Will a new elevator cab shell be acceptable?

Response: The existing cab shell shall be adequate.

Question 33: Hoistway Entrances – Shall doors and entrances be cleaned and polished or re clad with stainless steel?

Response: Yes, bid as specified.

Question 34: Please advise if the owner will be providing data and telephone line for the required video/audio emergency communication requirements or if a cellular line will be utilized. If cellular please advise would will be responsible for monthly service.

Response: Bidder is responsible for maintaining the system until the end of warranty period.

Question 35: Please confirm that MCPS will be responsible for the elevator communications monitoring subscription fees.

Response: Bidder is responsible for maintaining the system until the end of warranty period.

Question 36: Please clarify the extent/scope for the elevator parts and labor warranty that is to be provided with the base bid scope.

Response: 2 Years warranty part and labor.

Question 37: Please define the extent/scope for the elevator maintenance that is to be provided with the base bid scope. Note that the bid form has a segregated cost for elevator maintenance (separate from the base bid). We recommend that the 24-month maintenance contract be included in the base bid to avoid breakdowns / future issues.

Response: Bid as Specified.

Question 38: Please confirm when this contract will be issued. Note that adequate time must be given to the contractor in order to account for long lead items.

Response: November 2026.

Question 39: Has a hazardous conditions survey been performed at the areas of work?

Response: Yes.



Question 40: Please confirm that any hazardous materials abatement will not be the responsibility of the contractor if encountered. If asbestos-containing materials are identified, please confirm MCPS will complete abatement before June 21, 2027 and that the Contractor is responsible only for lead-safe work practices during repainting.

Response: Correct.

Question 41: Please confirm that the offeror will not be responsible for failure of elevator equipment caused by lack of regular maintenance if MCPS does not elect to award Bid Item #3 for Monthly Maintenance.

Response: Yes.

Question 42: Please confirm what the cost is for background checks?

Response: Allow \$45 per employee.

Question 43: Section 01 10 00- Part 1 General - 1.1. Summary -D.5 mentions doors and frames for new work and Section 08 31 00 was provided. Please confirm elevator machine room door, door frame and door accessories can be retained in place as they were observed to meet code.

Response: Machine room door/frame to remain.

Question 44: 1/ A5.1. Please define the limits of painting at each elevator lobby.

Response: Terminate new painting at nearest inside/outside corner on either side of elevator entrance.

Question 45: Per the site visit, it was mentioned there are multiple IT Closet Rooms. Please confirm the IT Closet at Level 2 beside the elevator can be used to connect the CAT6 cables for the elevator. If not, please provide the IT Room available with its approximate linear footage from the elevator.

Response: Use IT Closet mentioned above – Level 2 beside elevator.

Question 46: Per the site visit on Level "G", there is a stencil painting of "G" & "HALL" at the elevator lobby wall. Please confirm that this is to be protected and the contractor will not be responsible for repainting this decorative stencil painting.

Response: Correct.

Question 47: Is a general floor plan of the school available? Please provide any as-builts as available.

Response: Drawings will be made available to the selected contractor.

Question 48: If MCPS elects to not accept the segregated pricing for elevator maintenance, will the contractor be required to respond to elevator callbacks due to warranty issues for the installed materials even if the elevator equipment is not actively maintained?

- a. We recommend including the elevator maintenance in the base bid and revising the bid form to eliminate any potential defects caused by neglected elevator maintenance within the 2-year warranty period.



Response: Yes, during the two year Warranty period

RFI #2

Question 1: Please confirm if reveals are to be black or stainless. Specification states black while drawings indicate stainless.

Response: Reveals shall be stainless steel.

Question 2: Will the project schedule shift due to any delays from awarding and approving submittals? If the project schedule is delayed will work have to be performed after hours when students/teachers are no longer in the building?

Response: This is a possibility. However, bidders shall price based on all published schedules being held.

Question 3: If the schedule is not delayed all elevator-related work can commence during normal hours as the bid requirements mention there are summer school activities and work shall not affect any school activities or it shall be completed on weekends.

Response: Bidders shall price based on all published schedules being held.

Question 4: Can MCPS please confirm if the elevator interior cab fronts/transom shall be re-cladding in stainless steel or just cleaned and retained?

Response: Cab fronts/transoms can be cleaned and retained.

Question 5: Can MCPS please confirm if the elevator interior cab car door shall be re-cladding in stainless steel or just cleaned and retained?

Response: Interior cab door can be cleaned and retained.

Question 6: Can MCPS please confirm if the elevator exterior hoistway landing doors shall be re-cladding in stainless steel or just cleaned and retained?

Response: Exterior hoistway landing doors can be cleaned and retained.

Question 7: Can MCPS please confirm if the elevator exterior landing door frames shall be re-cladding in stainless steel or just cleaned and retained?

Response: Exterior hoistway landing door frames can be cleaned and retained.

Question 8: Please confirm if the elevator interior shall have black or stainless reveals as the specification states black and drawings state stainless steel.

Response: Reveals shall be stainless steel.

Question 9: Please confirm if the hall fixtures shall be surface or flush mounted.

Response: Provide flush mounted wall fixtures.



A. ARCHITECTURAL DRAWINGS and SPECIFICATIONS

None

B. MEP DRAWINGS and SPECIFICATIONS

Drawing Items (refers to items to be added to, deleted from, or replaced in regards to the project specifications):

Item no. 1	MP1.1 – Floor Plans DELETE: Redundant split system and sump pump in schedule titles ADD: SEER2 efficiency value for split system
Item No. 2	MP7.1 – Mechanical & Plumbing Details ADD: Note for continuous operation of elevator split system ADD: Code compliance note detail
Item no. 3	E0.1 – Electrical Legend & Abbreviations REVISE: General notes
Item no. 4	E1.1 – Floor Plans ADD: General Note 2 REVISE: Drawing Notes 5 & 6 ADD: Drawing Note 12 ADD: Disconnect location for SSCU ADD: Lighting control narrative ADD: Location plan
Item no. 5	E1.2 – Schedules ADD: Sheet in its entirety

Specification Items (refers to items to be added to, deleted from, or replaced in regards to the project specifications):

Item no. 1	Common Work Results Plumbing ADD: Full section
Item no. 2	Hangers and Supports Plumbing Piping & Equipment ADD: FULL SECTION
Item no. 3	ID for Plumbing Piping & Equipment ADD: Full section
Item no. 4	Plumbing Insulation ADD: Full section
Item no. 5	Sanitary Waste & Vent Piping ADD: Full section
Item no. 6	Sanitary Waste & Vent Specialties



ADD: Full section

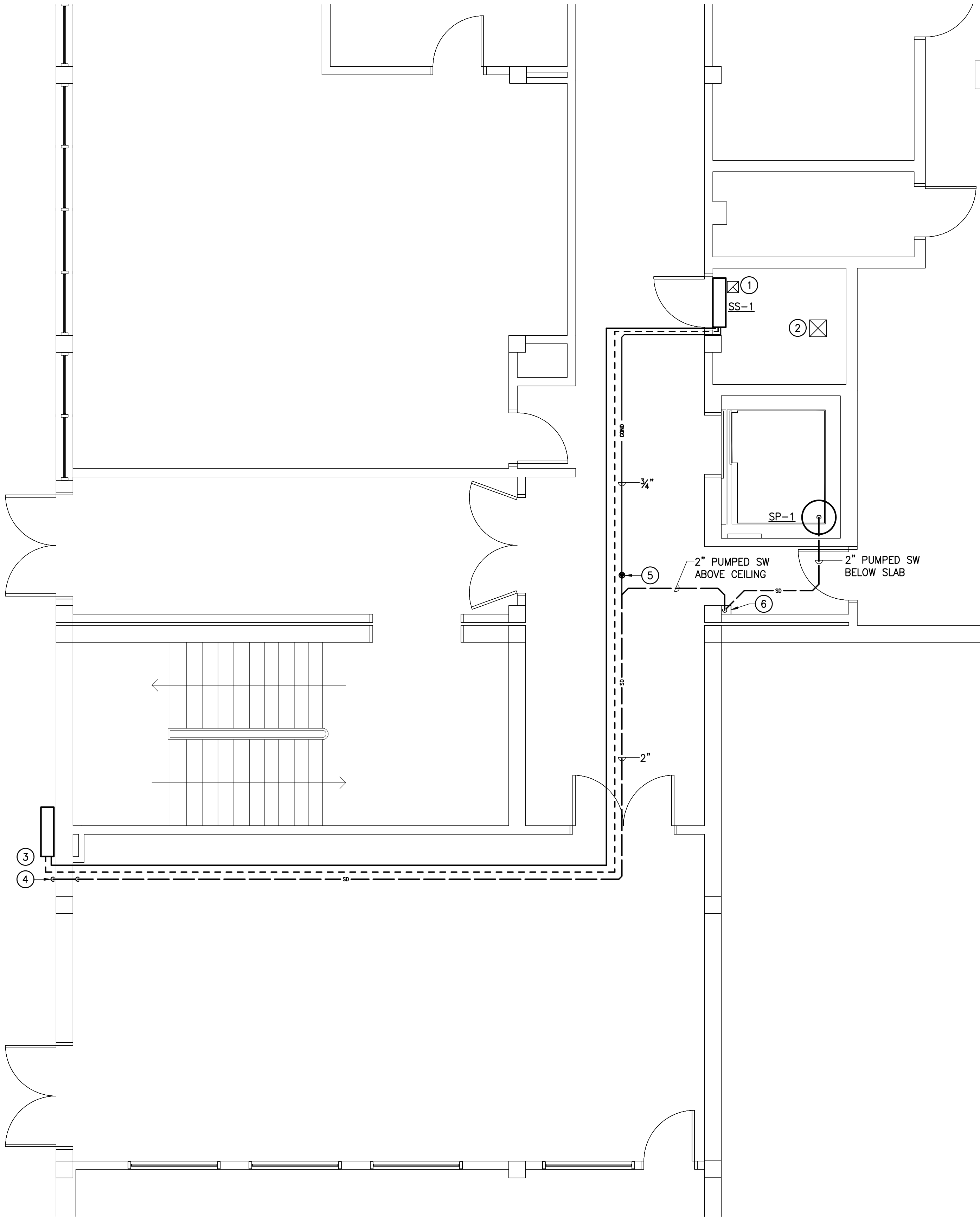
Item no. 7	Facility Storm Drainage Piping ADD: Full section
Item no. 8	Vibration Controls For Hvac Piping & Equipment ADD: Full section
Item no. 9	Testing, Adjusting And Balancing ADD: Full section
Item no. 10	New Instrumentation And Control For HVAC ADD: Full section

ATTACHMENTS:

1. Specs:
 - a. 220500 – Common work results plumbing
 - b. 220529 – Hangers supports for plumbing piping & equipment
 - c. 220553 – ID for plumbing piping & equipment
 - d. 220700 – Plumbing insulation
 - e. 221316 – Sanitary waste & vent piping
 - f. 221319 – Sanitary waste piping specialties
 - g. 221413 – Facility storm drainage piping
 - h. 230548 – Vibration controls HVAC piping & equipment
 - i. 230593 – Testing adjusting balancing HVAC
 - j. 230900 – New instrumentation and control for HVAC
2. Drawings:
 - a. MP1.1 – FLOOR PLANS
 - b. MP7.1 – MECHANICAL & PLUMBING DETAILS
 - c. E0.1 – ELECTRICAL LEGEND & ABBREVIATIONS
 - d. E1.1 – FLOOR PLANS
 - e. E1.2 – SCHEDULES

- End of Addendum #1 -





LOWER LEVEL PART PLAN

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

GENERAL NOTES:

1. ALL EXISTING ELECTRICAL AND EMR VENTILATION SYSTEMS SHALL BE REVIEWED TO CONFIRM PROPER SEQUENCE OF OPERATION.
2. PATCH ALL HOLES, PENETRATIONS, ETC. (IN WALLS, FLOORS, ETC.) TO MATCH EXISTING MATERIALS AND PAINT TO MATCH EXISTING FINISHES.

DRAWING NOTES:

- ① ETR EXHAUST GRILLE
- ② ETR SUPPLY DIFFUSER
- ③ REFRIGERANT PIPING THROUGH EXTERIOR WALL TO EXTERIOR WALL MOUNTED CONDENSING UNIT.
- ④ 2" PUMPED SW DISCHARGE TO SPLASHBLOCK AT GRADE.
- ⑤ CONNECT 3/4" CD TO 2" PUMPED STORM LINE WITH BACKWATER VALVE.
- ⑥ PROVIDE METAL PIPE ENCLOSURE FOR VERTICAL PIPING. PAINT TO MATCH EXISTING FINISHES.

EQUIPMENT NOTES

1. **ELEVATOR SUMP PUMP (SP-1):**
SUMP PUMP SHALL BE STANCOR OIL MINDER CONTROL SYSTEM MODEL SE-50. ASME A17.1, UL508 AND UL778 APPROVED. COMPLETE WITH NEMA 4X FIBERGLASS ENCLOSURE, STAINLESS STEEL SENSOR PROBE, PLUG IN POWER HOOK-UP.
A. 1/2 HP, 120V/1Ø/60HZ, 3600 RPM WITH 2" DISCHARGE
B. 2" CHECK VALVE
C. JUNCTION BOX WITH MULTI-PIN CONNECTOR AND CORD IN LENGTHS AS REQUIRED
D. OIL-MINDER POWER CABLE, PROBE CABLE AND FLOAT CABLE
E. HIGH LIQUID ALARM FLOAT WITH CLAMP DEVICE TO MOUNT ON PUMP DISCHARGE
F. CONTROL SYSTEM SHALL HAVE BUILT-IN AUDIBLE AND VISUAL ALARM WHEN THE PUMP DOESN'T OPERATE DUE TO OIL IN THE PIT, HIGH AMPERAGE OR HIGH LIQUID CONDITION. PROVIDE SILENCING BUTTON IN THE CONTROL PANEL. PROVIDE ADDITIONAL CONTACTS FOR MONITORING THROUGH THE ATC SYSTEM.
2. **SPLIT SYSTEM EVAPORATOR (SS-1):**
450 CFM, 18,000 BTU/H COOLING CAPACITY
80°F DB EAT, 67°F WB EAT
36"x12"x10", 30 LBS
BASED ON MITSUBISHI MODEL PKA-AL18NL
PROVIDE WITH MAXIBLUE BLUE DIAMOND MINI CONDENSATE PUMP W/ RESERVOIR AND SENSOR
3. **SPLIT SYSTEM CONDENSER (SS-1):**
95°F DB EAT
35"x12"x25", 100 LBS
208V/1Ø/60Hz. 20A MOCB
 19.5 SEER2
BASED ON MITSUBISHI MODEL PUY-AK18NL
PROVIDE WITH QSWBSS BRACKET FOR WALL MOUNTING 7' ABOVE GRADE

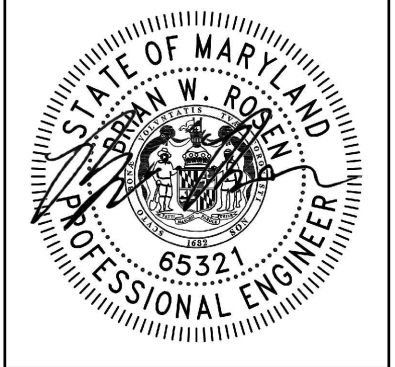


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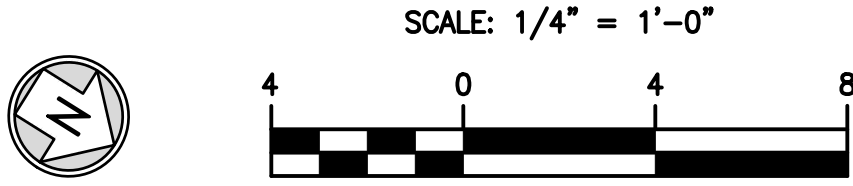
ELEVATOR MODERNIZATION FOR:
SPRINGBROOK HIGH SCHOOL
MONTGOMERY COUNTY PUBLIC SCHOOLS
201 VALLEY BROOK DRIVE
SILVER SPRING, MD 20904
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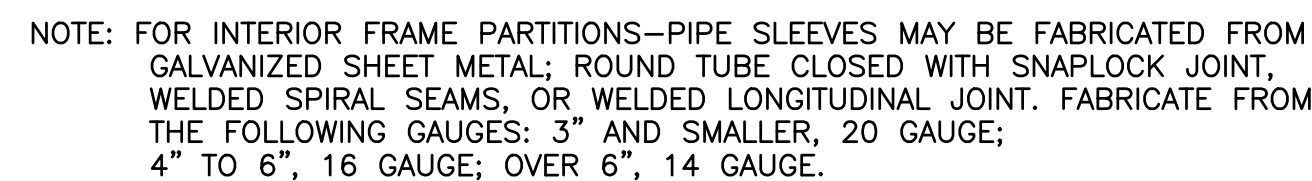
ISSUE		
REV	DATE	DESCRIPTION
	05/29/26	PROG. SET
	06/12/26	PERMIT SET
1	10/07/26	ADDENDUM #1

PROJECT NO.: 24-14.07
DATE: 10/06/2026

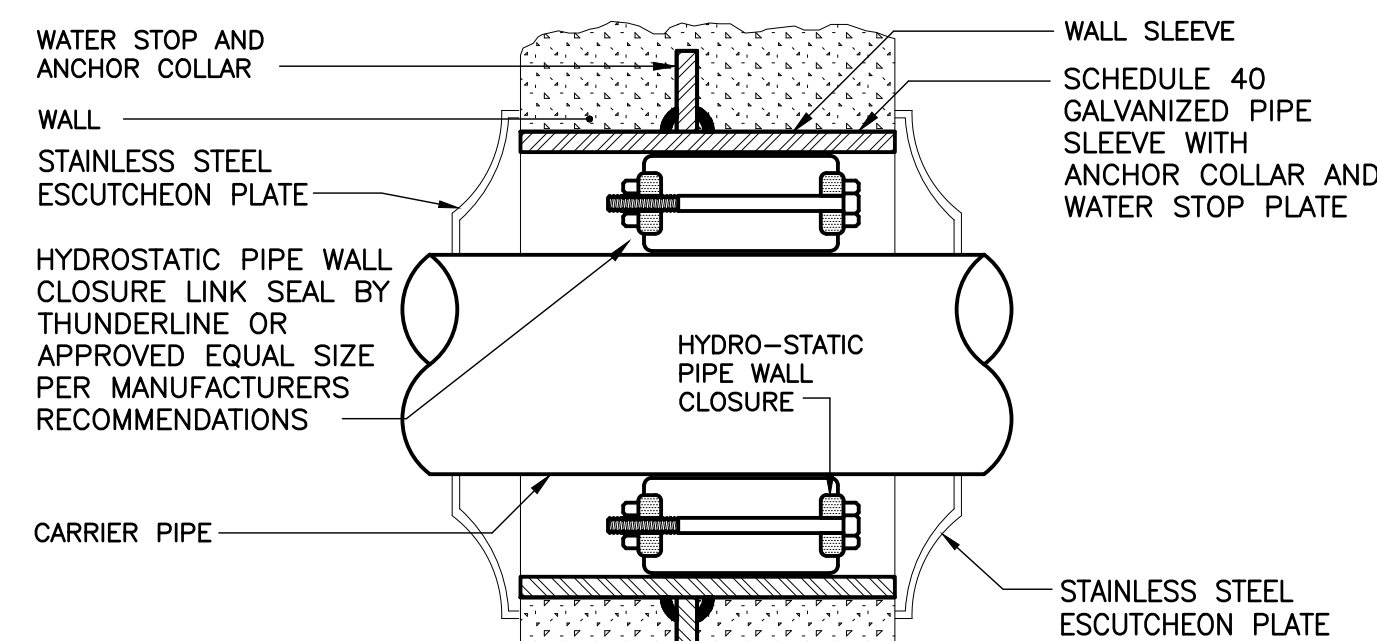
FLOOR PLANS

MP1.1

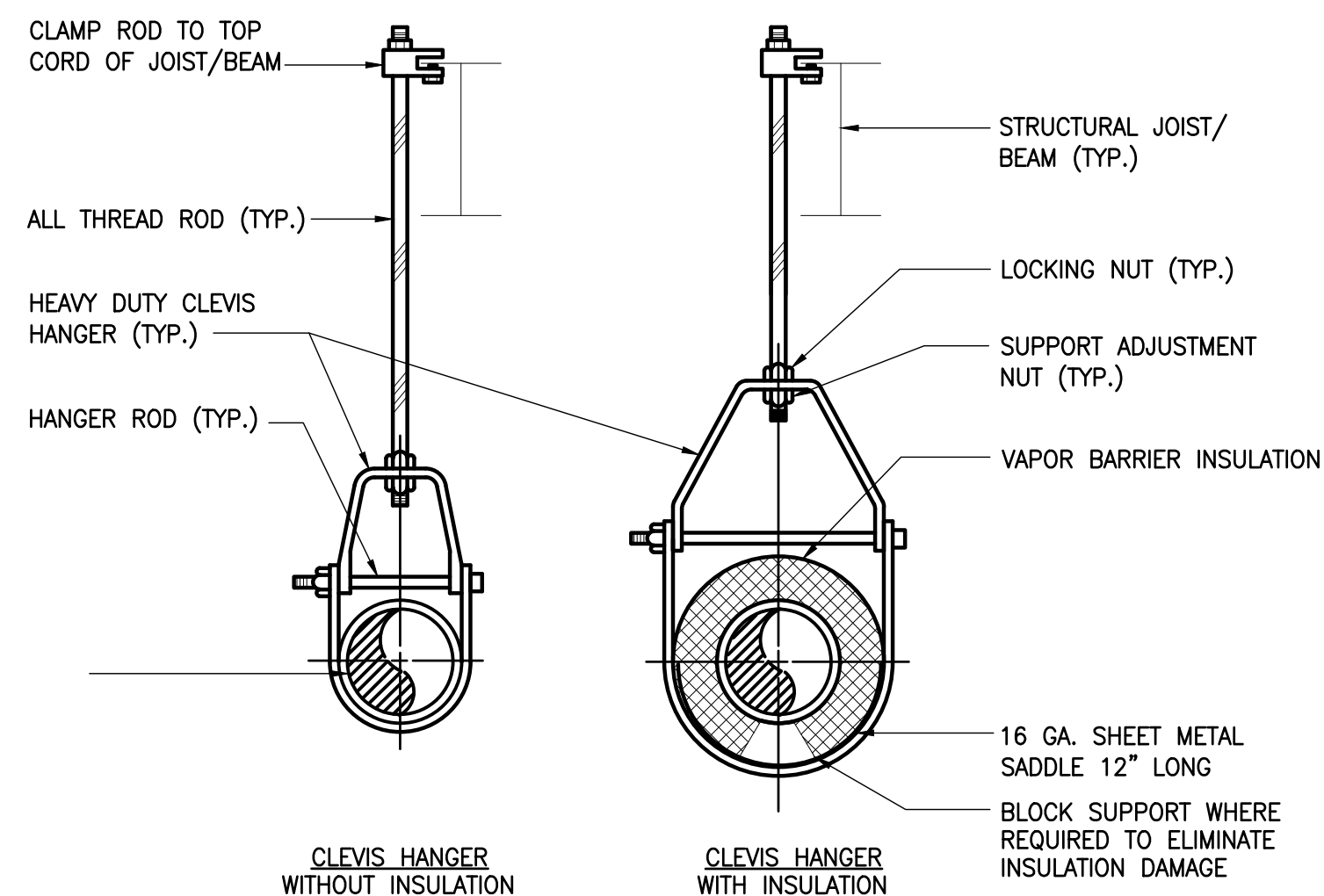




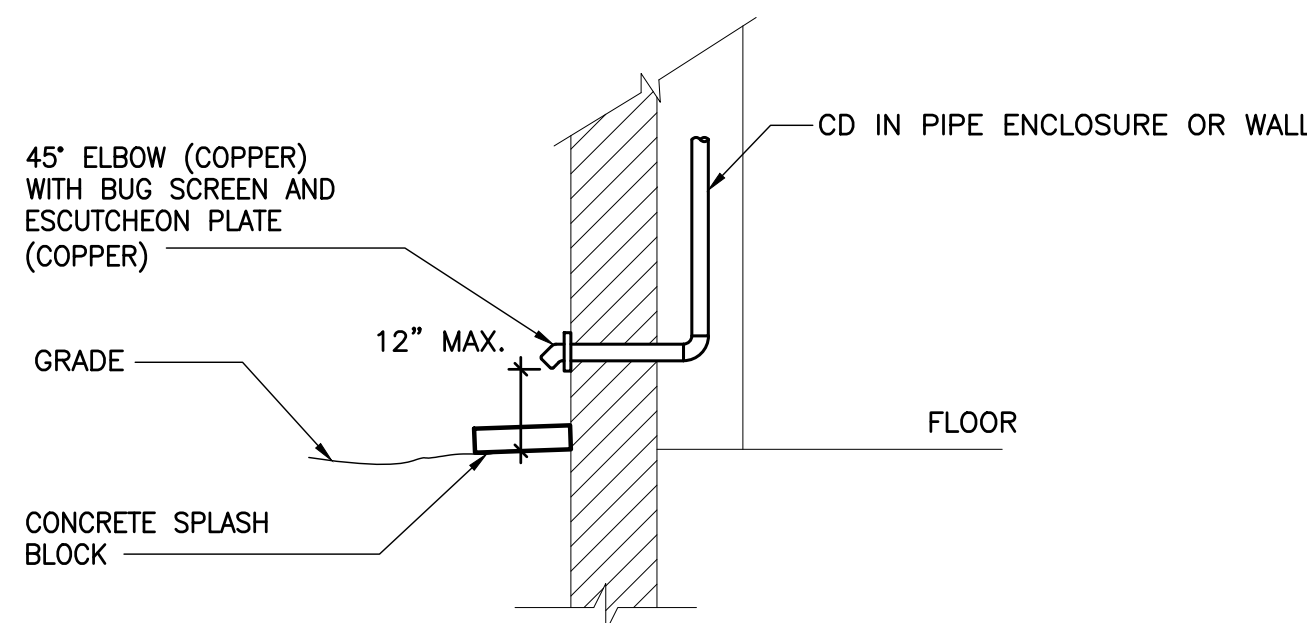
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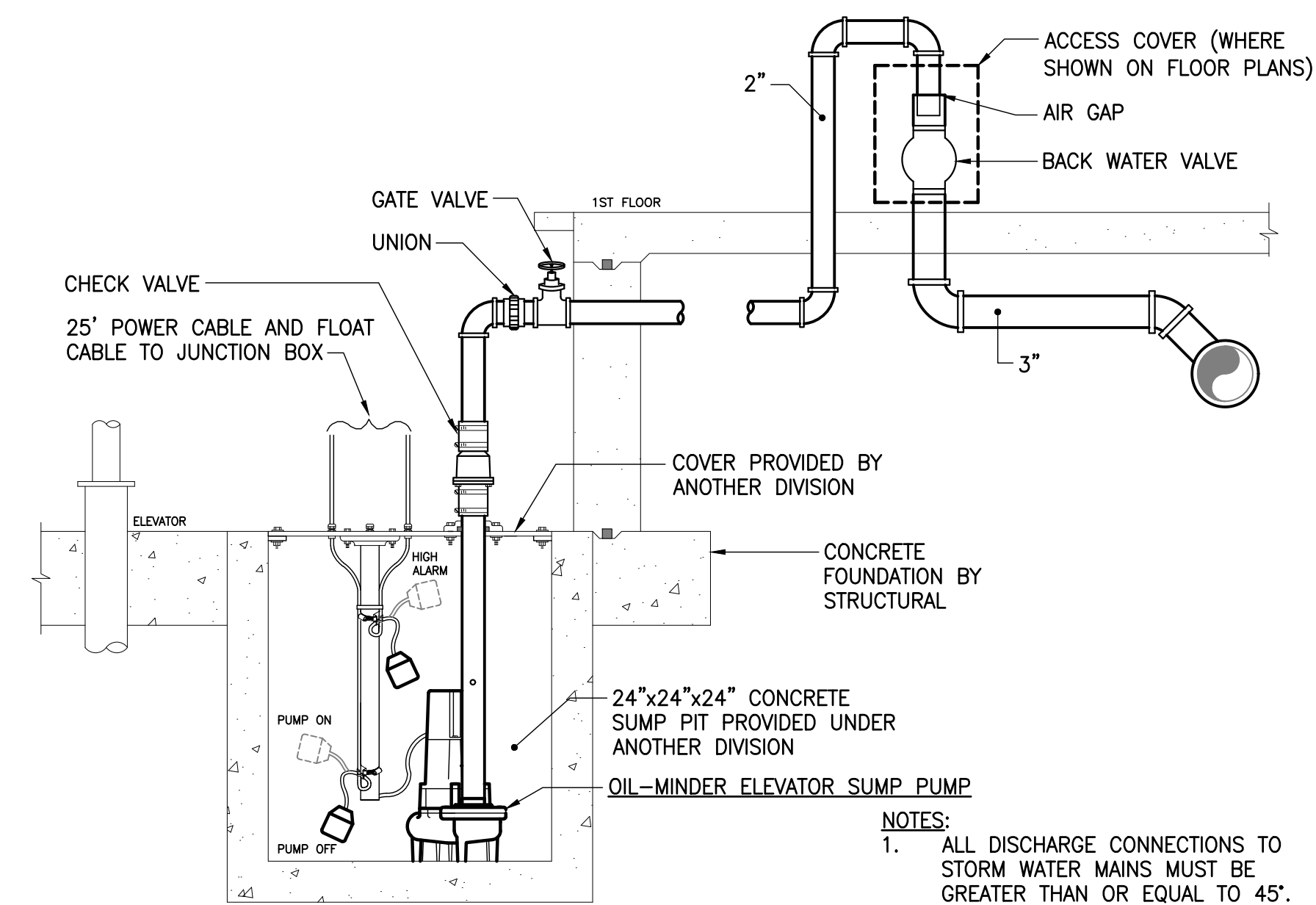
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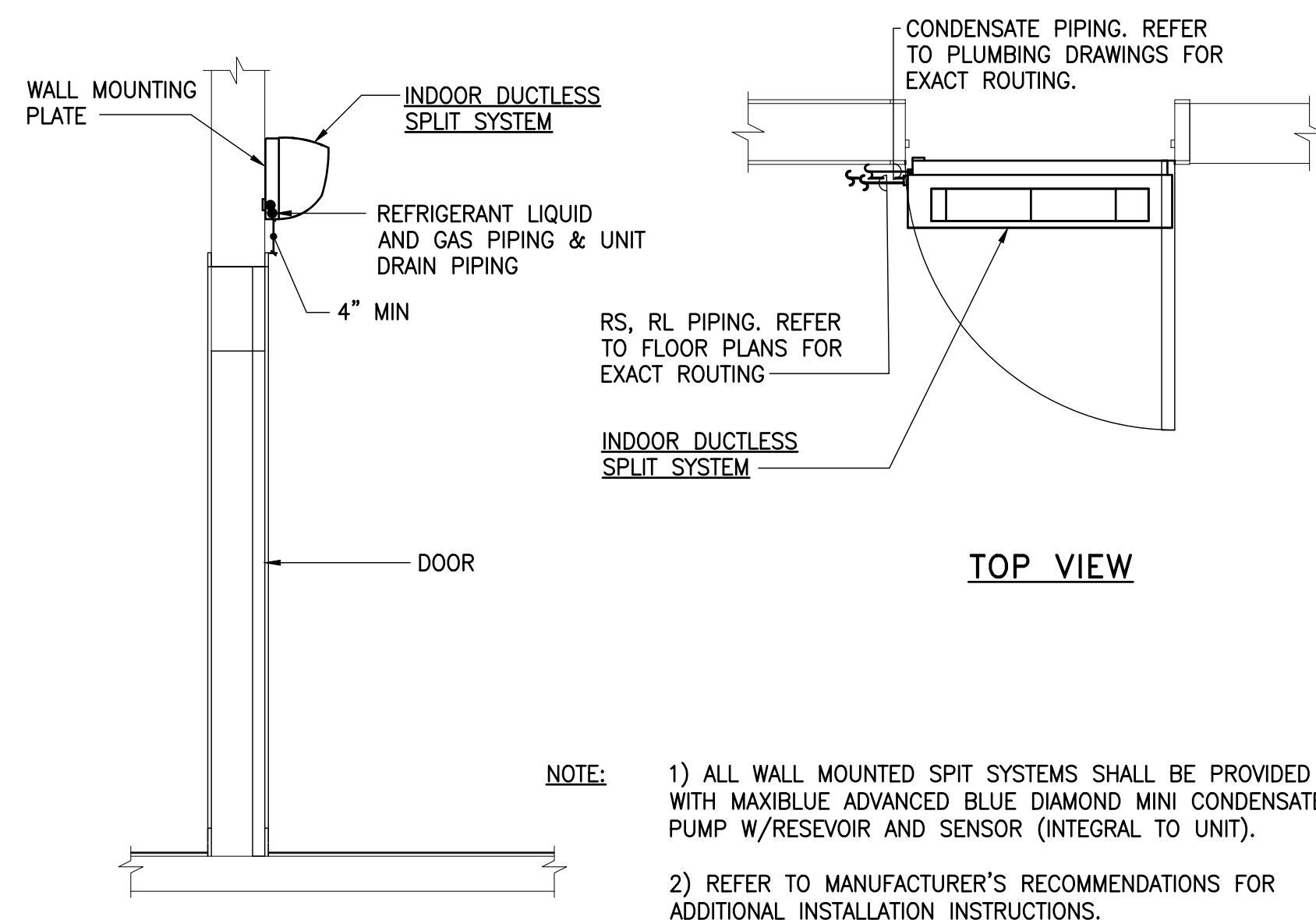
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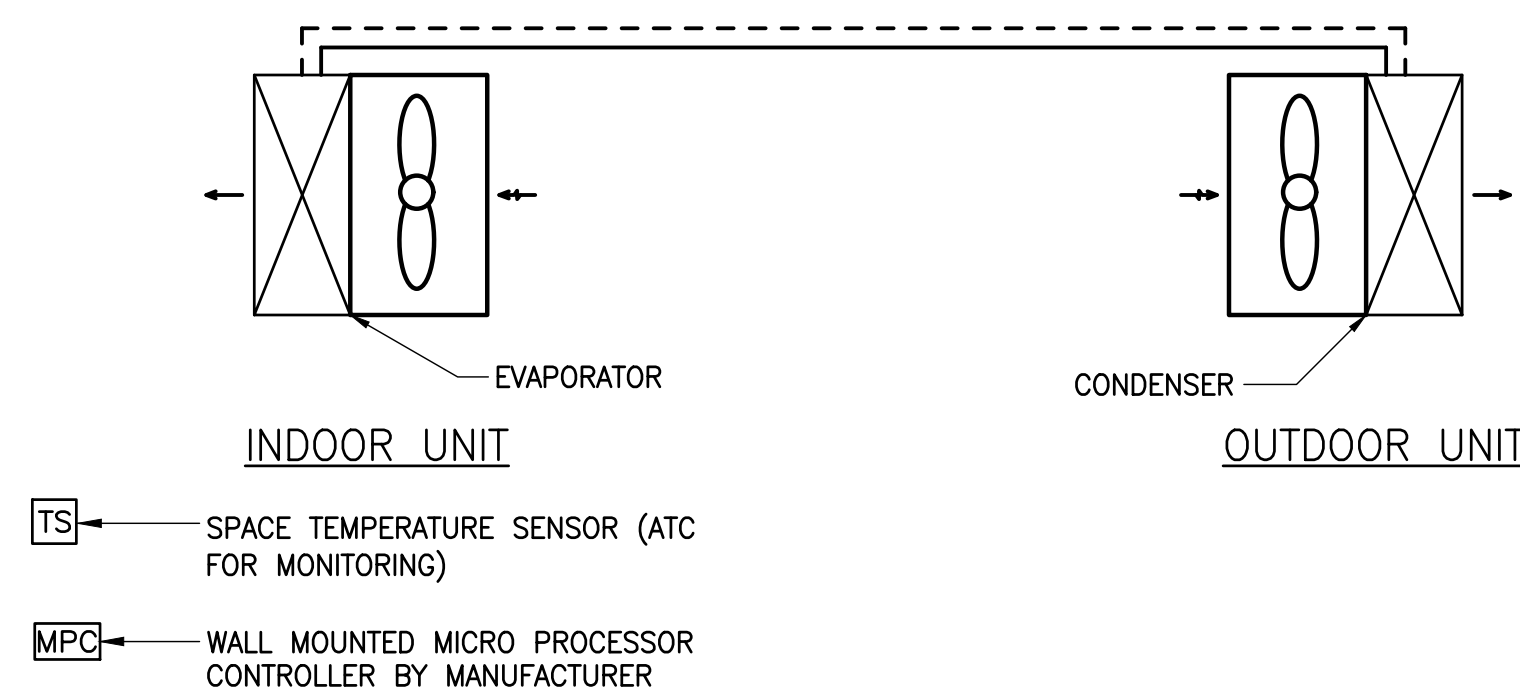
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SCALE: NONE



SCALE: NONE



1. MICRO PROCESSOR CONTROLLER SHALL SEQUENCE INDOOR A/C UNIT TO MAINTAIN 70°F (ADJUSTABLE).
2. SPACE TEMPERATURE SHALL MONITOR SPACE TEMPERATURE AND SEND AN ALARM TO THE EMS WHEN A HIGH TEMPERATURE SETPOINT LIMIT (80°F – ADJUSTABLE THROUGH SOFTWARE) IS REACHED.
3. FOR EACH PUMP UNITS THE MICROPROCESSOR CONTROLLER SHALL SEQUENCE INDOOR FAN COIL UNIT TO MAINTAIN 70°F (ADJUSTABLE)

NOTES:

1. SEQUENCE SHALL OPERATE AT ALL TIMES WHETHER BUILDING IS OCCUPIED OR UNOCCUPIED.

1

SCALE: NONE

1. ASHRAE 90.1 VENTILATION REQUIREMENTS DO NOT APPLY TO THIS PROJECT AS THIS ELEVATOR DOES NOT HAVE OR REQUIRE A VENTILATED SHAFT. REQUIREMENTS BASED ON ASHRAE 10.4.3 MUST BE DETERMINED BY THE ELEVATOR DESIGNER/INSTALLER.
2. SPLIT SYSTEM SS-1 SEER2 OF 19.5 IS ABOVE THE REQUIREMENT FROM ASHRAE 90.1 2022 OF 13.4
3. SYSTEM WILL BE BALANCED ACCORDING TO TAB SPEC SECTION 230593.
4. SEQUENCE OF OPERATION IS LOCATED IN DETAIL 8 ON THIS PAGE. SINCE THIS IS A COOLING ONLY SYSTEM WITH NO VENTILATION REQUIREMENT OR DOWNTIME, ASHRAE 90.1 REQUIREMENTS FOR DEADBAND, SETPOINT OVERLAP RESTRICTION, OFF-HOUR CONTROLS, DAMPER CONTROLS, ECONOMIZERS AND DEMAND CONTROL VENTILATION ALL DO NOT APPLY.

SCALE: NONE



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EXPIRATION DATE
2027/07/20



ELEVATOR MODERNIZATION FOR:
SPRINGBROOK HIGH SCHOOL
MONTGOMERY COUNTY PUBLIC SCHOOLS
201 VALLEY BROOK DRIVE
SILVER SPRING, MD 20904

[illegible]

PROJECT NO.:	24-14.07
DATE:	10/07/2026

ELECTRICAL LEGEND & ABBREVIATIONS

E0.1

1. THE ELECTRICAL CONTRACTOR SHALL FAMILIARIZE HIMSELF WITH THE DRAWINGS OF ALL OTHER TRADES ON THE PROJECT. ELECTRICAL OR SYSTEMS CONNECTIONS INDICATED ON ARCHITECTURAL, MECHANICAL, CIVIL, STRUCTURAL, KITCHEN AND ALL OTHER DRAWINGS WHICH ARE PART OF THIS PROJECT, SHALL BE CONSIDERED A PART OF THIS CONTRACT AND SHALL BE PROVIDED BY THE ELECTRICAL CONTRACTOR AT NO EXTRA COST TO THE OWNER.
2. THE ELECTRICAL DRAWINGS ARE DIAGRAMMATIC IN NATURE AND AS SUCH SHALL NOT BE SCALED. REFER TO THE ARCHITECTURAL DRAWINGS FOR EXACT LOCATIONS OF DEVICES AND EQUIPMENT AND DIGITAL INFORMATION PRIOR TO ROUTING. COORDINATE LOCATION OF MECHANICAL EQUIPMENT WITH MECHANICAL CONTRACTOR PRIOR TO ROUGH-IN OF SERVICE EQUIPMENT AND WIRING.
3. COORDINATE MOUNTING HEIGHTS OF ALL DEVICES WITH ARCHITECTURAL PLANS, SECTIONS, ELEVATIONS AND CASEWORK DRAWINGS.
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR DETERMINING THE EXACT ROUTING OF WIRING AND CONDUITS AND SHALL BE RESPONSIBLE FOR SIZING ALL BRANCH CIRCUIT WIRING TO LIMIT VOLTAGE DROP TO 3%. CONTRACTOR SHALL SIZE CONDUIT TO ACCOMMODATE WIRING PER NEC.
5. ELECTRICAL BOXES IN FIRE RATED PARTITIONS SHALL NOT EXCEED 16 SQUARE INCHES IN AREA (IF 4"x4"), SHALL BE MADE OF STEEL, AND SHALL BE SUCH THAT THE CUMULATIVE AREA OF BOX "CUTOUTS" IN THE FIREWALL DOES NOT EXCEED 100 SQUARE INCHES PER 100 SQUARE FEET OF WALL AREA. ELECTRICAL BOXES ON THE SIDES OF THE SAME FIREWALL SHALL BE SEPARATED BY A HORIZONTAL VERTICAL DISTANCE OF NOT LESS THAN 24 INCHES. THE ELECTRICAL CONTRACTOR SHALL MAKE MINOR ADJUSTMENTS, AS NECESSARY, TO ELECTRICAL BOX LOCATIONS TO ENSURE COMPLIANCE WITH THIS REQUIREMENT SINCE BOX LOCATIONS ARE TYPICALLY NOT DIMENSIONED ON THE DRAWINGS. CONSULT ARCHITECT IF CLARIFICATION IS REQUIRED.
6. NEW WALLS ARE SHADED ON THE FLOOR PLANS, EXISTING WALLS ARE NOT SHADED. CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING MOUNTING OF DEVICES WITH WALL TYPE.

1. DEMOLITION DRAWINGS ARE DIAGRAMMATIC IN NATURE; NO ATTEMPT HAS BEEN MADE TO SHOW ALL EXISTING ELECTRICAL WORK IN AREAS INDICATED TO BE RENOVATED. ALL EXISTING ELECTRICAL WORK IS TO REMAIN UNLESS OTHERWISE NOTED. WHEN AN ITEM TO BE REMOVED, REMOVE ALL ASSOCIATED ELECTRICAL WORK BACK TO POINT-OF-SOURCE.
2. WHERE WORK PASSES THROUGH THE RENOVATION AREA TO SERVE OTHER PORTIONS OF THE BUILDING, OR WORK IN THE RENOVATION AREA INDICATED TO BE REMAIN, IT SHALL BE SUITABLY RELOCATED AND THE SYSTEMS RESTORED TO NORMAL. COORDINATE ANY OUTAGES WITH OWNER 7 DAYS IN ADVANCE.
3. WORK INDICATED TO REMAIN SHALL BE SUITABLY PROTECTED AGAINST DAMAGE.
4. DISPOSE OF ALL PCB CONTAINING FLUORESCENT AND HID BALLASTS IN ACCORDANCE WITH EPA, DOT, STATE AND LOCAL REGULATIONS. IF THE PCB CONTENT IS NOT STATED ON THE BALLAST LABEL, THE BALLAST LABEL SHALL BE HANDLED AS A PCB BALLAST. DISPOSE OF ALL FLUORESCENT, INCANDESCENT AND HID LAMPS IN ACCORDANCE WITH EPA, DOT, STATE AND LOCAL REGULATIONS.
5. TURN OVER ALL CIRCUIT BREAKERS, LIGHTING AND APPLIANCE PANELBOARD COVERS, CONTACTORS, MOTOR STARTERS, TIME CLOCKS, BATTERY PACKS, CLOCKS, SPEAKERS, ETC THAT ARE IN GOOD CONDITION TO OWNER. CONTACT OWNER FOR VERIFICATION IF ITEMS ARE IN QUESTIONABLE CONDITION.
6. COORDINATE ALL DEMOLITION AND CONSTRUCTION ACTIVITIES WITH THE OWNER TO MINIMIZE DISRUPTION OF THE NORMAL DAILY FUNCTIONING OF THE OWNERS OCCUPIED AREAS.
7. REMOVE AND REINSTALL ALL EXISTING CEILING MOUNTED DEVICES INDICATED TO REMAIN AS REQUIRED TO SUIT NEW CEILING INSTALLATION.
8. REFER TO ARCHITECTURAL FLOOR PLANS FOR EXISTING WALLS. ALL NEW DEVICES LOCATED ON EXISTING WALLS SHALL BE FISHED TO BE INSTALLED CONCEALED AND FLUSH TO THE WALL; IF FISHING CANNOT OCCUR PROVIDE APPROPRIATE SERIES WIREMOLD TO SURFACE MOUNT DEVICES.
9. ALL REMOVED DEVICE WALL PENETRATIONS SHALL BE PATCHED AND PAINTED TO MATCH EXISTING WALL COLOR OR WALL COLOR PER ARCHITECT'S DIRECTION.

(MOUNTING HEIGHTS ARE TO CENTERLINE OF DEVICE UON)

	LIGHT FIXTURE. TYPE AS SPECIFIED. REFER TO LIGHT FIXTURE SCHEDULE.
	WALL MOUNTED LIGHT FIXTURE. TYPE AS SPECIFIED. REFER TO LIGHT FIXTURE SCHEDULE.
	INDICATES LIGHT FIXTURE ON EMERGENCY CIRCUIT (GENERATOR).
	EXIT SIGNAGE - CEILING MOUNTED, WALL MOUNTED AT 6" ABOVE DOOR. SHADING INDICATES ILLUMINATED FACE. DIRECTIONAL ARROWS AS INDICATED. AC ONLY OPERATION, CONNECTED TO EMERGENCY CIRCUIT (GENERATOR).

S PILOT LIGHT TOGGLE SWITCH; MOUNT AT 48" AFF

 CONTACTOR; SIZE AS NOTED; IN NEMA 1 ENCLOSURE UON; MOUNT AT 5'-6" AFF TO TOP UON

S LINE VOLTAGE TOGGLE SWITCH. SUBSCRIPT INDICATES FIXTURES CONTROLLED. MOUNT AT 48" A.F.F. U.O.N.

WP GFI EWC °C	TAMPER RESISTANT DUPLEX RECEPTACLE; 2P, 3W, 20A, 125V, NEMA 5-20R; MOUNT AT 18" AFF UON; SUBSCRIPTS: GFI – GROUND FAULT INTERRUPTER CIRCUIT BREAKER, WP – WEATHERPROOF AND WEATHER RESISTANT, TR – TAMPER RESISTANT, C – MOUNT AT 42", EWC – MOUNT CONCEALED BEHIND WATER FOUNTAIN.
	TAMPER RESISTANT DUPLEX RECEPTACLE; 2P, 3W, 20A, 125V, NEMA 5-20R; MOUNT AT 42" AFF UON.
	SPECIAL RECEPTACLE; AS NOTED; MOUNT AT 18" AFF UON.
	TAMPER RESISTANT DUPLEX RECEPTACLE; 2P, 3W, 20A, 125V, NEMA 5-20R; GROUND FAULT CIRCUIT INTERRUPTING MOUNT AT 18" AFF UON.
	TAMPER RESISTANT DUPLEX RECEPTACLE; 2P, 3W, 20A, 125V, NEMA 5-20R; GROUND FAULT CIRCUIT INTERRUPTING MOUNT AT 42" AFF UON.
	TAMPER RESISTANT DUPLEX RECEPTACLE; 2P, 3W, 20A, 125V, NEMA 5-20R; WEATHERPROOF AND WEATHER RESISTANT, GROUND FAULT CIRCUIT INTERRUPTING MOUNT AT 18" AFF UON.

	HOMERUN TO PANELBOARD; REFER TO PANEL SCHEDULES FOR MINIMUM WIRE AND CONDUIT SIZES
	BRANCH CIRCUIT CONDUIT AND WIRING CONCEALED IN CEILING OR WALL SPACE, OR SURFACE MOUNTED WHERE NO CEILING OR WALL SPACE EXISTS; REFER TO PANEL SCHEDULES FOR MINIMUM WIRE AND CONDUIT SIZES
	BRANCH CIRCUIT CONDUIT AND WIRING IN SLAB, UNDER FLOOR OR UNDERGROUND; REFER TO PANEL SCHEDULES FOR MINIMUM WIRE AND CONDUIT SIZES

① REFERENCE TO DRAWING NOTE DETAIL REFERENCE:

DETAIL NUMBER/DRAWING NUMBER

ITEMS SHOWN DASHED/HEAVY ARE TO BE REMOVED

ITEMS SHOWN SOLID/LIGHT ARE EXISTING TO REMAIN

ITEMS SHOWN DASHED-DOTTED/LIGHT ARE TO OCCUR
IN FUTURE PHASES

PHOTO REFERENCE NUMBER, ARROW FACING
DIRECTION OF PHOTO.

	FIRE ALARM PULL STATION; MOUNT AT 48" AFF
	SMOKE DETECTOR
	DUCT TYPE SMOKE DETECTOR
	SPRINKLER SYSTEM VALVE TAMPER SWITCH
	SPRINKLER SYSTEM FLOW SWITCH
	HEAT DETECTOR
	CONTROL MODULE
	MONITORING MODULE
	FIRE ALARM ANNUNCIATOR/FIRE ALARM CONTROL PANEL AS NOTED

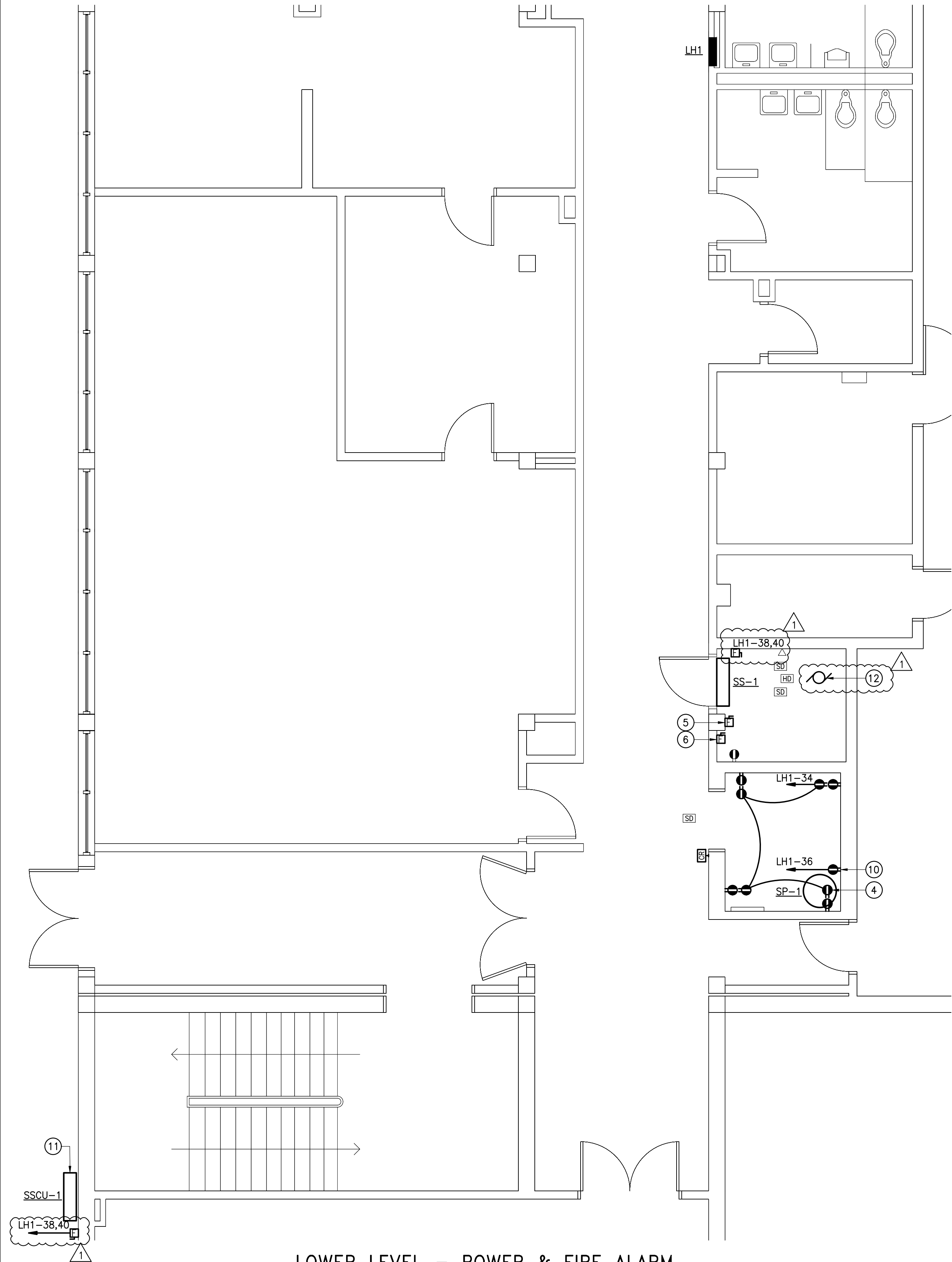
	DISTRIBUTION PANELBOARD, SURFACE MOUNTED AT 6'-6" AFF TO TOP OF PANEL.
	PANELBOARD; RECESSED, SURFACE MOUNTED; MOUNT AT 5-6" AFF TO TOP OF PANEL.
	SINGLE POLE MANUAL MOTOR STARTING SWITCH WITH PILOT LIGHT MOUNT AT 48" AFF IN NEMA 1 ENCLOSURE UON
	MOTOR; AS NOTED
	SAFETY DISCONNECT SWITCH; FUSED, NONFUSED IN NEMA 1 ENCLOSURE UON; MOUNT AT 48" AFF UON; RATING AND FUSING AS NOTED
	JUNCTION BOX
	TRANSFORMER

 CARD READER; MOUNT AT 48" A.F.F. TO TOP OF DEVICE.
PROVIDE BACK BOX WITH 3/4" EMPTY CONDUIT WITH PULL
STRING TO ACCESSIBLE CEILING TERMINATED IN BUSHED END.

A	AMPERE, AMPERES	MDF	MAIN DISTRIBUTION FRAME
AFB	ABOVE FINISHED FLOOR	MLO	MAIN LUGS ONLY
AHU	AIR HANDLING UNIT	MPOP	MAIN POINT OF PRESENCE
AIC	AMPERE INTERRUPTING CAPACITY	MSB	MAIN SWITCHBOARD
ATS	AUTOMATIC TRANSFER SWITCH	MTD	MOUNTED
AWG	AMERICAN WIRE GAUGE	MH	MOUNTING HEIGHT/MANHOLE
CATV	CABLE TELEVISION	NEC	NATIONAL ELECTRICAL CODE
CCTV	CLOSED CIRCUIT TELEVISION	NEMA	NATIONAL ELECTRICAL
CD	CONDUIT	NECA	MANUFACTURER'S ASSOCIATION
CB	CIRCUIT BREAKER	NF/SS	NONFUSED SAFETY SWITCH
DWG	DRAWING	NO	NUMBER
ECB	ENCLOSED CIRCUIT BREAKER	OC	ON CENTERS
EF	EXHAUST FAN	P	POLE, POLES
EPO	EMERGENCY POWER OFF	Ø	PHASE
ETR	EXISTING TO REMAIN	PNL	PANEL
EWC	ELECTRIC WATER COOLER	PVC	POLYVINYL CHLORIDE
EX	EXISTING	RAF	RETURN AIR FAN
FAAP	FIRE ALARM ANNUNCIATOR PANEL	RGS	RIGID GALVANIZED STEEL
FACP	FIRE ALARM CONTROL PANEL	RX	REMOVE EXISTING
FLA	FULL LOAD AMPERES	TYP	TYPICAL
FSS	FUSED SAFETY SWITCH	TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR
G	GROUND	UH	UNIT HEATER
GFEP	GROUND FAULT EQUIPMENT PROTECTION	V	VOLT, VOLTS
GFI	GROUND FAULT INTERRUPTING	VR	VANDALL RESISTANT
HOA	HAND-OFF-AUTOMATIC	WP	WEATHERPROOF
HP	HORSEPOWER	W	WATTS, WIRE, WIRES
HWH	HOT WATER HEATER GENERATOR	XFMR	TRANSFORMER
IDF	INTERMEDIATE DISTRIBUTION FRAME	ITB	TELEPHONE TERMINAL BOARD
IMC	INTERMEDIATE METAL CONDUIT	UTP	UNSHIELDED TWISTED PAIR
KCMIL	THOUSAND CIRCULAR MILS	UON	UNLESS OTHERWISE NOTED
KVA	KILOVOLT-AMPERES		
KW	KILOWATT		
LRA	LOCKED ROTOR AMPERES		
MCA	MINIMUM CIRCUIT AMPERES		
MCB	MAIN CIRCUIT BREAKER		

LIGHTING CONTROL NARRATIVE:

1. MACHINE SPACES
1.g. NO OCCUPANCY BASED CONTROLS, LINE VOLTAGE TOGGLE ONLY.
2. ELEVATOR HOISTWAYS
2.g. NO OCCUPANCY BASED CONTROLS, LINE VOLTAGE TOGGLE ONLY.



LOWER LEVEL – POWER & FIRE ALARM

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

LEVEL 1 – ELEVATOR

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

LEVEL 2 – ELEVATOR

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

LEVEL 3 – ELEVATOR

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

ELEVATOR PIT – LIGHTING

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

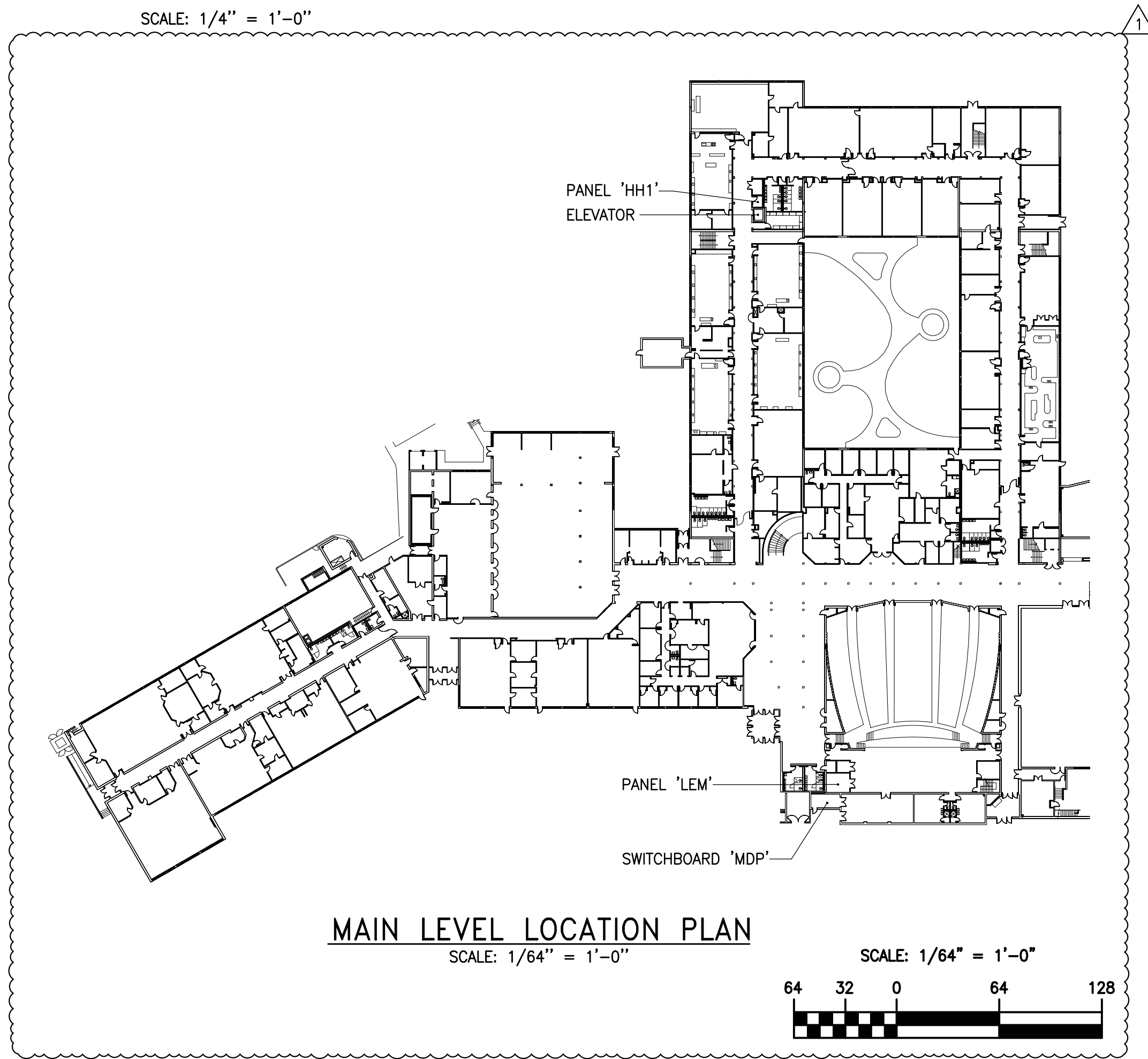
TOP OF ELEVATOR SHAFT – LIGHTING

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

LOWER LEVEL ELEVATOR MACHINE ROOM – LIGHTING

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

LOWER LEVEL – DEMOLITION



MAIN LEVEL LOCATION PLAN

SCALE: 1/64" = 1'-0"

SCALE: 1/64" = 1'-0"

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

GENERAL NOTES:

1. AFTER DEMOLITION OF ELECTRICAL EQUIPMENT, ALL HOLES, PENETRATIONS, ETC. LEFT IN EXISTING WALLS, FLOORS, ROOF, ETC. SHALL BE PATCHED AND PAINTED TO MATCH ADJACENT FINISHES.D
2. REFER TO DRAWING E1.2 FOR ADDITIONAL CIRCUITING INFORMATION.

DRAWING NOTES:

- 1 RX. DISCONNECT. PRESERVE CABLING AND CONDUIT FROM POINT OF SOURCE.
- 2 RX. ELEVATOR MACHINERY AND ALL ASSOCIATED ELECTRICAL APPURTENANCES.
- 3 REMOVE LIGHT FIXTURE. PRESERVE BRANCH LIGHTING CIRCUIT FOR RECONNECTION TO NEW FIXTURES.
- 4 GF/WP RECEPTACLE SHALL BE MOUNTED 2'-6" ABOVE BOTTOM OF ELEVATOR PIT AND 2'-6" BELOW TOP OF ELEVATOR SHAFT (TYPICAL).
- 5 PROVIDE LOCKABLE 3P-100A-F/SS (FUSED @ 90A). REUSE CABLING AND CONDUIT PRESERVED DURING DEMOLITION. COORDINATE LOCATION AND AUXILIARY CONTACTS WITH ELEVATOR MANUFACTURER'S RECOMMENDATIONS. MAKE CONNECTION TO EXISTING SHUNT TRIP CIRCUIT BREAKER [IN SWITCHBOARD 'MDP'].
- 6 PROVIDE LOCKABLE 2P-30A-F/SS (FUSED @ 20A) FOR ELEVATOR CAB LIGHTS. REUSE CABLING AND CONDUIT PRESERVED DURING DEMOLITION [FROM PANEL 'LEM']. MAKE ALL CONNECTIONS AS REQUIRED.
- 7 PROVIDE MERCURY LIGHTING TYPE LW4.4.3800.35K.HTA.1%UNI SERIES OR APPROVED EQUAL (TYPICAL).
- 8 PROVIDE MERCURY LIGHTING TYPE L701.4.3400.40K.ASW.1%UNI.SSL SERIES OR APPROVED EQUAL. FIXTURE IS RATED FOR WALL MOUNTING IN HORIZONTAL OR VERTICAL ORIENTATIONS. FIELD COORDINATE WITH ELEVATOR MANUFACTURER AND ALL OTHER TRADES REQUIRED PRIOR TO ROUGH-IN (TYPICAL).
- 9 MAKE CONNECTION TO BRANCH LIGHTING CIRCUIT [FROM PANEL 'HH1'] PRESERVED DURING DEMOLITION AHEAD OF ALL LOCAL CONTROLS. MODIFY/EXTEND CIRCUIT AS REQUIRED TO MAKE ALL CONNECTIONS WITH (2)#12 + #12GW IN 3/4" CONDUIT.
- 10 MOUNT TO SUIT SUMP PUMP IN ELEVATOR PIT. PROVIDE FRACTIONAL MOTOR STARTER SWITCH WITH GREEN PILOT LIGHT (MOUNTED AT PUMP). MAKE ALL CONNECTIONS TO PUMP CONTROLLER AS REQUIRED.
- 11 PROVIDE 3P-30A-F/SS (FUSED PER MANUFACTURER'S NAMEPLATE DATA) MOUNT AT OUTDOOR UNIT AND CONNECT TO ASSOCIATED SS INDOOR UNIT. PROVIDE 3P-30A-F/SS (FUSED PER MANUFACTURER'S NAMEPLATE DATA) AT INDOOR UNIT.
- 12 NEW ELEVATOR MOTOR, 480V, 3 PHASE, 25 HP. NO BACKUP POWER OR GENERATOR FIELD CONTROL.

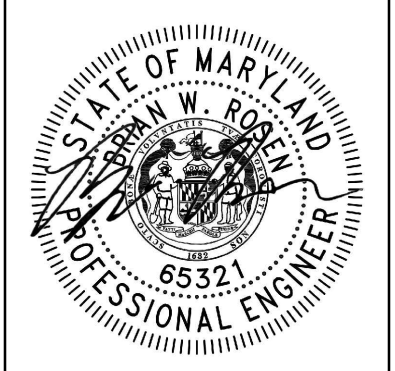


PROFFITT & ASSOCIATES
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I CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY A PROFESSIONAL ENGINEER DULY LICENSED UNDER THE LAWS OF THE STATE OF MARYLAND.
LICENSE No. 65321
EXPIRATION DATE 2027/07/20



ELEVATOR MODERNIZATION FOR:
SPRINGBROOK HIGH SCHOOL
MONTGOMERY COUNTY PUBLIC SCHOOLS
201 VALLEY BROOK DRIVE
SILVER SPRING, MD 20904
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ISSUE		
REV	DATE	DESCRIPTION
	05/29/26	PROG. SET
	06/12/26	PERMIT SET
1	10/07/26	ADDENDUM #1

PROJECT NO.: 24-14.07
DATE: 10/07/2026

FLOOR PLANS

E1.1



PROFFITT & ASSOCIATES
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MONTGOMERY COUNTY PUBLIC SCHOOLS
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ISSUE		
REV	DATE	DESCRIPTION
	05/29/26	PROG. SET
	06/12/26	PERMIT SET
1	10/07/26	ADDENDUM #1

PROJECT NO.: 24-14.07
DATE: 10/07/2026

SCHEDULES

E1.2

MDP													
MOUNTING: FREE STANDING				A.I.C. RATING: EXISTING					LOCATION: MAIN ELEC RM				
VOLTAGE: 480/277V, 3ø, 4 WIRE				3000 AMPERE MAIN BUS					3000 AMPERE MAIN CIRCUIT BREAKER				
DISTRIBUTION SECTION													
FDR NO	SERVES	CIRCUIT BREAKER			WIRING					REMARKS	CON KVA		
		P	FRAME	TRIP	SETS	NO	SIZE	GND	C				
1	EX CHILLER	3	600	600							249.4		
2	SPACE	3											
3	EX. PANEL HBR	3	600	600							199.5		
4	SPACE	3											
5	EX. PANEL HH3	3	400	400							133.0		
6	EX. ELEVATOR	3	90	90	1	3	2	8	1-1/4"		37.4		
7	EX. PANEL HFF	3	400	400							133.0		
8	SPACE	3											
9	EX. PANEL HD3	3	400	400							133.0		
10	SPACE	3											
11	EX. PANEL HB	3	40	400							133.0		
12	EX. PANEL HH1 & HH2	3	250	250							62.4		
13	EX. ATS-1	3	400	400							99.8		
14	EX. PANEL HF	3	250	250							103.9		
15	EX. ATS-2	3	100	100							41.6		
16	EX. PANEL HC1 & HC2	3	200	200							66.5		
17	SPACE	3											
18	EX. PANEL HK	3	150	150							62.4		
19													
20													
21													
22													
23													
24													
PROVIDE GROUND FAULT PROTECTION AT MAIN CIRCUIT BREAKER											TOTAL CONNECTED LOAD		1454.9 KVA

PANEL HH1										MOUNTING: SURFACE									
VOLTAGE: 480/277V,3ø,4W										LOCATION: ELECTRICAL ROOM									
400 AMPERE BUS				MAIN LUGS ONLY						100% RATED NEUTRAL BUS						EXISTING A.I.C.			
CONN KVA	CKT	DESCRIPTION	BREAKER P AMPS	CIRCUIT WIRING					CKT	DESCRIPTION	BREAKER P AMPS	CIRCUIT WIRING					CONN KVA		
				NO	SIZE	GND	C	NO				SIZE	GND	C					
0.4	1	EX. LTG G-1, G-3	1 20						2	EX. LTG CORRIDOR	1 20						0.8		
0.4	3	EX. LTG G-3B, G-11	1 20						4	EX. LTG G-2, G-4, G-5	1 20						0.6		
0.4	5	EX. LTG G-10 [MACH RM]	1 20	2	12	12	3/4"		6	EX. LTG G-12	1 20						0.2		
0.6	7	EX. CIRCUIT	1 20						8	EX. CIRCUIT	1 20						0.6		
0.6	9	EX. CIRCUIT	1 20						10	EX. LTG F108	1 20						0.2		
0.4	11	EX. LTG G103, G104	1 20						12	EX. LTG F104, F106	1 20						0.4		
0.2	13	EX. LTG G101	1 20						14	EX. LTG F107, F109	1 20						0.4		
0.4	15	EX. LTG F110, F111	1 20						16	EX. LTG F1043, F105	1 20						0.4		
0.2	17	EX. LTG F113	1 20						18	EX. LTG G108	1 20						0.2		
0.4	19	EX. LTG F112	1 20						20	EX. LTG G111, G111A	1 20						0.4		
0.4	21	EX. LTG F102, E116	1 20						22	EX. LTG G105	1 20						0.2		
0.2	23	EX. LTG F101	1 20						24	EX. LTG G107, G107A	1 20						0.4		
0.2	25	EX. LTG G106	1 20						26	EX. LTG G110, G110B	1 20						0.4		
0.2	27	EX. LTG G109	1 20						28	EX. LTG CORRIDOR	1 20						0.8		
	29	SPACE							30	SPACE									
TOTAL CONNECTED LOAD				11.0 KVA					KVA PER PHASE:				A	4.4	B	4.2	C	2.4	

PANEL LEM										MOUNTING: SURFACE									
VOLTAGE: 208/120V,3ø,4W										LOCATION: STORAGE ROOM									
100 AMPERE BUS				MAIN LUGS ONLY						100% RATED NEUTRAL BUS						EXISTING A.I.C.			
CONN KVA	CKT	DESCRIPTION	BREAKER		CIRCUIT WIRING				CKT	DESCRIPTION	BREAKER		CIRCUIT WIRING				CONN KVA		
			P	AMPS	NO	SIZE	GND	C			P	AMPS	NO	SIZE	GND	C			
0.6	1	EX. CIRCUIT	1	20					2	EX. CIRCUIT	1	20					0.6		
0.6	3	EX. CIRCUIT	1	20					4	EX. CIRCUIT	1	20					0.6		
0.6	5	EX. CIRCUIT	1	20					6	EX. CIRCUIT	1	20					0.6		
0.6	7	EX. CIRCUIT	1	20					8	EX. CIRCUIT	1	20					0.6		
0.6	9	EX. CIRCUIT	1	20					10	EX. CIRCUIT	1	20					0.6		
0.6	11	EX. CIRCUIT	1	20					12	EX. CIRCUIT	1	20					0.6		
0.6	13	EX. CIRCUIT	1	20					14	EX. CIRCUIT	1	20					0.6		
0.6	15	EX. CIRCUIT	1	20					16	EX. CIRCUIT	1	20					0.6		
0.4	17	EX. ELEV CAB LTG	1	20	2	12	12	3/4"	18	EX. CIRCUIT	1	20					0.6		
0.6	19	EX. CIRCUIT	1	20					20	EX. CIRCUIT	1	20					0.6		
0.6	21	EX. CIRCUIT	1	15					22	EX. CIRCUIT	1	20					0.6		
0.6	23	EX. CIRCUIT	1	15					24	EX. CIRCUIT	1	20					0.6		
0.6	25	EX. CIRCUIT	1	20					26	SPACE	1								
	27	SPACE	1						28	SPACE	1								
	29	SPACE	1						30	SPACE	1								
	31	SPACE	1						32	SPACE	1								
	33	SPACE	1						34	SPACE	1								
	35	SPACE	1						36	SPACE	1								
	37	SPACE	1						38	SPACE	1								
	39	SPACE	1						40	SPACE	1								
	41	SPACE	1						42	SPACE	1								
TOTAL CONNECTED LOAD			14.8 KVA						KVA PER PHASE:			A	5.4	B	4.8	C	4.6		

PANEL LH1										MOUNTING: RECESSED									
VOLTAGE: 208/120V,3ø,4W										LOCATION: CORRIDOR									
100 AMPERE BUS				MAIN LUGS ONLY						100% RATED NEUTRAL BUS				EXISTING A.I.C.					
CONN KVA	CKT	DESCRIPTION	BREAKER P AMPS	CIRCUIT WIRING NO SIZE GND C					CKT	DESCRIPTION	BREAKER P AMPS	NO	SIZE	GND	C	CONN KVA			
0.8	1	EX. RM G-11 UV	1	15					2	EX. REC G-3	1	20					0.6		
0.2	3	EX. EWC	1	20					4	EX. REC G-1	1	20					0.6		
0.6	5	EX. REC G-2	1	20					6	EX. REC G-3B	1	20					0.6		
0.6	7	EX. REC G-11	1	20					8	EX. REC G-11	1	20					0.6		
0.6	9	EX. REC G-12	1	20					10	EX. FAN	1	20					0.8		
0.6	11	EX. REC G-12	1	20					12	EX. FAN	1	15					0.8		
0.6	13	EX. REC CORRIDOR	1	20					14	EX. REC G-3	1	20					0.6		
0.6	15	EX. REC G-2	1	20					16	EX. REC G-1	1	20					0.6		
0.4	17	EX. CIRCUIT	1	20					18	EX. CIRCUIT	1	20					0.4		
0.4	19	EX. CIRCUIT	1	20					20	EX. CIRCUIT	1	20					0.4		
0.4	21	EX. CIRCUIT	1	20					22	EX. CIRCUIT	1	20					0.4		
0.4	23	EX. CIRCUIT	1	20					24	EX. CIRCUIT	1	20					0.4		
0.4	25	EX. CIRCUIT	1	20					26	EX. CIRCUIT	1	20					0.4		
0.4	27	EX. CIRCUIT	1	15					28	EX. CIRCUIT	1	20					0.4		
0.8	29	EX. UV G-3B	1	15					30	EX. CIRCUIT	1	15					0.4		
0.2	31								32	LTG - ELEVATOR SHAFT	1	20	2	12	12	3/4"	0.4		
0.2	33	EX. SEWAGE PUMP	3	15					34	REC - ELEVATOR SHAFT	1	20	2	12	12	3/4"	0.8		
0.2	35								36	REC - SUMP PUMP	1	20	2	12	12	3/4"	0.4		
	37	SPACE							38	SSCU-1	2	25	2	10	10	3/4"	1.5		
	39	SPACE							40								1.5		
	41	SPACE							42	SPACE									
TOTAL CONNECTED LOAD			21.0 KVA						KVA PER PHASE:			A	7.5	B	7.5	C	6.0		

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

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 the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Equipment installation requirements common to equipment sections.
 - 9. Painting and finishing.
 - 10. Concrete bases.
 - 11. Supports and anchorages.
- B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all mechanical work.
- C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.
- D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange piping, equipment, and other work generally as shown on the contract drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with "Submittals" specified below. The right is reserved to make reasonable changes in location of equipment, piping, and ductwork, up to the time of rough-in or fabrication.
- E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.
- F. Coordinate the work under Division 22 with the work of all other construction trades.
- G. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the contract documents.

- H. Coordinate with all exterior work with the sprinkler contractor.
- I. Coordinate all exterior work with the site/general trades contractor.
- J. The plumbing contractor shall provide all condensate drain piping and all gas piping to mechanical equipment connections.
- K. Provide all piping and connections in the kitchen as coordinated with the kitchen contractor and food service drawings.
- L. All domestic water system materials shall be NSF61 certified as lead free.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, 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.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. 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 shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. PE: Polyethylene plastic.
 - 4. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Escutcheons.
- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. 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.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations. Coordinate the work under Division 22 with work of all other construction trades. Conform to the requirements of all rules, regulations, and Codes of local, state, and Federal Authorities Having Jurisdiction.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces.

1.8 PERMITS AND FEES

- A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.
- B. Permits and fees shall comply with the General Requirements of the specification.

1.9 EXAMINATION OF SITE:

- A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for Contractor's failure to do so.

1.10 CONTRACTOR QUALIFICATION

- A. Any Contractor or Subcontractor performing work under Division 22 shall be fully qualified and acceptable to the Architect. Submit the following evidence if requested.
 - 1. A list of not less than five comparable projects that the Contractor completed.
 - 2. Letter of reference from not less than three registered professional engineers, Contractors or building owners.
 - 3. Local and/or State License, where required.
 - 4. Membership trade or professional organizations where required.
- B. A Contractor is any individual, partnership, or corporation, performing work by contract or subcontract on this project.
- C. Acceptance of a Contractor or Subcontractor will not relieve the Contractor or subcontractor of any contractual requirements or his responsibility to supervise and coordinate the work, of various trades.

1.11 MATERIALS AND EQUIPMENT

- A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality. This Contractor shall be responsible for connecting all utilities as shown on the drawings, to equipment identified as "under another Division".
- B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal only of other manufacturers who are indicated in this specification, subject to approval by the Engineer and the Warrior Run School District. Alternate manufacturers or items other than the first-named shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.
- C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Alternate manufacturers/items are items other than first named which shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Manufacturers not named are not acceptable and shall not be submitted.
- D. Substitution will not be permitted for specified items of material or equipment where only one manufacturer is identified.
- E. The Contractor shall only submit those manufacturers indicated in the specification. Proposed alternate manufacturers must be approved by the Owner and be included into the specifications by Addenda. Substitutions are for materials or manufacturers not listed in this specification. For each substitution proposed by the Contractor, the Contractor shall clearly indicate all differences from the specified item, change in Contract cost, benefit to the Owner and a brief description why the substitution is being proposed. Refer to the General Conditions for additional information. The Owner shall ultimately accept/reject all substitution requests. Refer to the General Conditions of this specification for additional information.

1.12 FIRE SAFE MATERIALS

- A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA OR ASTM Standards for Fire Safety with Smoke and Fire Hazard Rating not exceeding flame spread of 25 and smoke developed of 50.

1.13 REFERENCED STANDARDS, CODES AND SPECIFICATIONS:

- A. Specifications, Codes and Standards listed below are included as part of this specification, latest edition.

AABC	-	Associated Air Balance Council
ABMA	-	American Boiler Manufacturers Association
ACCA	-	Air Conditioning Contractors of America
ACGIH	-	American Conference of Governmental Industrial Hygienist
ADC	-	Air Diffusion Council
AIHA	-	American Industrial Hygiene Association
AGA	-	American Gas Association
AMCA	-	Air Movement and Control Association
ANSI	-	American National Standards Institute
ARI	-	Air Conditioning and Refrigeration Institute
ASA	-	Acoustical Society of America
ASHRAE	-	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	-	American Society of Mechanical Engineers
ASTM	-	American Society for Testing and Materials
AWWA	-	American Water Works Association
CABO	-	Council of American Building Officials
CAGI	-	Compressed Air and Gas Institute
CS	-	Commercial Standard
CSA	-	Canadian Standards Association
CTI	-	Cooling Tower Institute
HEI	-	Heat Exchanger Institute
HI	-	Hydraulic Institute
HYDI	-	Hydronics Institute
IAPMO	-	International Association of Plumbing and Mechanical Officials
IBC	-	International Building Code
IBR	-	Institute of Boiler and Radiator Manufacturers
ICBO	-	International Conference of Building Officials
IEEE	-	Institute of Electrical and Electronics Engineers
IFCI	-	International Fire Code Institute
IMC	-	International Mechanical Code
IPC	-	International Plumbing Code
MSSP	-	Manufacturers Standards Society of the Valve and Fittings Industry
NEC	-	National Electrical Code
NEMA	-	National Electrical Manufacturers Association
NFPA	-	National Fire Protection Association
NSF Int.	-	National Sanitation Foundation
SMACNA	-	Sheet Metal and Air Conditioning Contractors National Association
TEMA	-	Tubular Exchanger Manufacturers Association
UL	-	Underwriters' Laboratories

- B. All mechanical equipment and materials shall comply with the Codes and Standards listed in the latest ASHRAE Handbook.

1.14 SUBMITTALS, REVIEW AND ACCEPTANCE:

- A. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Engineer to be in best interest of Owner.
- B. With 30 calendar days after award of contract, submit a complete Material and Equipment List for approval. List all proposed materials and equipment, indicating proposed manufacturer, type, class, model and other general identifying information.
- C. After acceptance of Material and Equipment List, submit complete descriptive data for all items. Data shall consist of specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, installation instructions, and any other information necessary to indicate complete compliance with Contract Documents. Edit submittal data specifically for application to this project.
- D. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and any electrical requirements for equipment submitted. Contractor shall be responsible for correctness of all submittals. Each piece of equipment and its associated components (e.g., relays, fuses, disconnects, etc.) shall be clearly identified.
- E. Submittals will be reviewed for general compliance with design concept in accordance with contract documents, but dimensions, quantities, or other details will not be verified.
- F. Identify submittals, indicating intended application, location and service of submitted items. Refer to specification sections or paragraphs where applicable. Clearly indicate exact type, model number, style, size and special features of proposed item. Submittals of a general nature will not be acceptable. For items other than first-named, clearly list on the first page of the submittal all differences between the specified item and the proposed item. The Contractor shall be responsible for all additional cost and for corrective action (or replacement with the specified item) while maintaining the specification requirements if differences have not been clearly indicated in the submittal.
- G. Submit actual operating conditions or characteristics, including NC Levels, for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable.
- H. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted.

1.15 SHOP DRAWINGS:

- A. Prepare and submit shop drawings for all specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings, or where the proposed installation differs from that shown on contract drawings.
- B. Submit data and shop drawings as listed below, in addition to provisions of Paragraph A above. Identify all shop drawings by the name of the item and system and the applicable specification paragraph number.
Items and Systems Not Limited to:

Access Doors.
Backflow Preventer.

- Capacitors.
- Chemical Treatment System.
- Cope Salt System.
- Domestic water booster pump.
- Fire Stopping - Methods and Materials.
- Floor & Roof Drains.
- Flowmeters and Primary Elements. (Flow Fittings)
- Hot Water Heater
- Hose Bibbs & Wall Hydrants.
- Hydro-pneumatic Tanks.
- Identification System.
- Mixing Valve, Temperature Limiting Valves.
- Pipe Guides and Anchors.
- Pipes and Fittings.
- Plumbing Fixtures & Trim.
- Pressure Booster System.
- Pressure Regulating Valve.
- Pressure Reducing Valve.
- Pressure Relief Valve.
- Sleeves and Sealants.
- Strainers.
- Thermal Insulation Materials.
- Thermometers and Gauges.
- Trap Seals.
- Valves - Globe, Angle, Check, Plug, Butterfly, Ball.
- Vibration Isolation.
- Water Softner.
- Water Treatment System.
- Well Pump and Controls.

- C. The Contractor, additionally, shall submit for approval any other shop drawings as required by the Architect. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Architect.

1.16 SUPERVISION AND COORDINATION:

- A. Provide complete supervision, direction, scheduling, and coordination of all work under the Contract, including that of subcontractors.
- B. Coordinate rough-in of all work and installation of sleeves, anchors, and supports for piping, and other work performed under Division 22.
- C. Coordinate electrical work required under Division 22 with that under Division 26. Coordinate all work under Division 22 with work under all other Divisions.

1.17 CUTTING AND PATCHING:

- A. Accomplish all cutting and patching necessary for the installation of work under Division 22. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, saw-cut or core drill only, and perform work in neat and workmanlike manner. Use mechanics skilled in the particular trades required.

- B. Do not cut structural members without approval.

1.18 PENETRATION OF WATERPROOF CONSTRUCTION:

- A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.
- B. Where plumbing vents or other pipes penetrate roofs, flash pipe with All American, Inc., or approved equal, roof flashing assemblies, 6-inch skirt, cap, and caulked counterflashing sleeve, installed by Roofing Contractor.
- C. Furnish pipe curbs and portals where required. Pitch pockets are prohibited. The Roofing Contractor shall install pipe curbs and portals.
- D. Furnish and install roof drains, curbs, vent assemblies, and duct sleeves specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions, The National Roofing Contractors Association, SMACNA and as required by other divisions of this specification. The Contractor shall be responsible for sleeve sizes and locations.

1.19 VIBRATION ISOLATION

- A. Furnish and install vibration isolators, flexible connections, supports, anchors, and/or foundations required to prevent transmission of vibration from equipment or piping to building structure.

1.20 ACCESSIBILITY

- A. All equipment shall be installed in such a way that all components requiring access are so located and installed that they may be serviced, reset, replaced, recalibrated, etc., by service technicians in accordance with the Manufacturer's recommendations. If any equipment or components are located in such a position that this Contractor cannot comply with the above, the Contractor shall notify the Engineer in writing before equipment is installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, galvanized steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.

2.4 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Industries, Inc.; DMD Div.
 - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
 - d. JCM Industries.
 - e. Smith-Blair, Inc.

- f. Viking Johnson.
- 2. Underground Piping NPS 1-1/2 (DN 40) and Smaller: Manufactured fitting or coupling.
- 3. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
- 4. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. Eslon Thermoplastics.
 - b. Charlotte Pipe.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. Thompson Plastics, Inc.
 - b. Charlotte Pipe.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - 1. Manufacturers:
 - a. NIBCO INC.
 - b. NIBCO, Inc.; Chemtrol Div.
 - c. Charlotte Pipe.
- E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.
 - d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

1. Manufacturers:
 - a. Epco Sales, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Flowset.
- D. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
 1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.
- E. Dielectric Unions and Couplings are prohibited.

2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 2. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: Stainless Steel. Include two for each sealing element.
 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

- A. Galvanized Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 1. Underdeck Clamp: Clamping ring with set screws.
- C. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.8 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- C. One-Piece, Floor-Plate Type: Cast-iron floor plate.

2.9 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. 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 Coordination Drawings.
- 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 to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.

- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
- M. Permanent sleeves are not required for holes formed by removable PE sleeves.
- N. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- O. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are two pipe sizes larger than pipe or pipe insulation.
 - a. Galvanized Steel Pipe Sleeves: For pipes through walls and floors except where noted through membrane waterproofing.
 - b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing. Seal space outside of sleeve fittings with grout.
 - c. Provide galvanized steel sheet sleeves for interior stud partitions.
 - d. Provide galvanized steel wall sleeves with sleeve seal system for walls below grade and concrete slabs on grade. Select sleeve size to allow one-inch annular clear space between piping and sleeve for installing sleeve seal system. Select type, size and number of sealing elements required for piping material and size for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve 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 water-tight seal.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

- P. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size two pipe sizes larger than pipe and sleeve for installing mechanical sleeve seals.
- Q. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- S. Verify final equipment locations for roughing-in.
- T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. 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.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 4. PVC Nonpressure Piping: Join according to ASTM D 2855.
 - 5. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 (DN 50) and smaller at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- C. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, vibration isolators, etc., shall be galvanized or stainless steel. All fasteners including nuts, bolts, washers, rods, etc., shall be stainless steel.

- D. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.
- E. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.
- F. Protect all finishes and restore any finishes damaged as a result of work under Division 22 to their original condition.
- G. The preceding requirements apply to all work, whether exposed or concealed.
- H. Remove all construction marking and writing from exposed equipment, piping and building surfaces. Do not paint manufacturer's labels or tags.
- I. All exposed piping, equipment, cast iron boots, etc. shall be painted. Colors shall be selected by the Architect and conform to ANSI Standards.

3.6 CONCRETE BASES

- 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 (100 mm) larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use 5000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Miscellaneous Cast-in-Place Concrete."

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.

- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.9 SUPPORTS AND HANGERS

- A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.
- B. Supports hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. For uninsulated copper piping/tubing provide copper clad hanger. All exterior hangers shall be constructed of galvanized steel or stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.

3.10 PROVISIONS FOR ACCESS:

- A. The Contractor shall provide access panels and doors for all concealed equipment, valves, strainers, cleanouts, traps, and other devices requiring maintenance, service, adjustment, balancing or manual operation.
- B. Where access doors are necessary, furnish and install manufactured steel door assemblies consisting of hinged door, cam locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. All proposed access door locations shall be approved by the Architect prior to installation. Door size shall be a minimum of 24" x 24" unless otherwise approved by the Architect/Engineer. Provide UL Approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, or approved equal.
 - 1. Acoustical or Cement Plaster: Style B
 - 2. Hard Finish Plaster: Style K or L
 - 3. Masonry or Dry Wall: Style M
- C. Where access is by means of lift-out ceiling tiles or panels, mark each panel using small color-coded or numbered tabs. Provide a chart or index for identification. Charts shall be similar to valve charts specified hereinafter. Provide chart in O & M Manual and in the Boiler Room. Screw markers shall be mounted on the ceiling grid using districts standard for marking and ID.
- D. Access panels, doors, etc., described herein shall be furnished under the section of specifications providing the particular service to be turned over to the pertinent trade for installation. Coordinate installation with installing Contractor. Coordinate locations with the Architect prior to installation.

3.11 PROTECTION OF WORK:

- A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.
- B. Cover temporary openings in piping and equipment to prevent the entrance of water, dirt, debris, or other foreign matter.
- C. Cover or otherwise protect all finishes.
- D. Replace damaged materials, devices, finishes and equipment.

3.12 OPERATION OF EQUIPMENT:

- A. Clean all systems and equipment prior to initial operation for testing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.
- B. Provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment.
- C. Do not use plumbing systems for temporary services during construction unless authorized in writing by the Owner or Architect. Where such authorization is granted, temporary use of equipment shall in no way limit or otherwise affect warranties or guaranty period of the work. All equipment safeties shall be functional and equipment operated within the recommended and designed parameters.
- D. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items such as filters, blowdown all strainers, etc.

3.13 IDENTIFICATIONS, FLOW DIAGRAMS, ELECTRICAL DIAGRAMS AND OPERATING INSTRUCTIONS

- A. Contractor shall submit for approval schematic piping diagrams of each piping system installed in the building. Diagrams shall indicate valve location, service, type (i.e., butterfly, globe, ball, etc.) make, model number and the identification number of each valve in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under glass and hung in the Mechanical Room where directed. Contractor shall deliver the AutoCAD or Revit developed color print and DVD or CD from which the diagrams were reproduced to the Owner.
- B. All valves shall be plainly tagged.
- C. All items of equipment shall be furnished with white letters and numbers on laminated identification plates using the districts coding system to match districts PM system requirements. Lettering shall be a minimum of 1/4" high. Identification plates shall be securely affixed to each piece of equipment, starters, panels, etc., by screws or adhesive (Tuff-bond #TB2 or as approved equal). Pressure sensitive tape backing is prohibited for all concealed equipment and devices located above drop tile ceilings.
- D. Provide three (3) copies of operating and maintenance instructions for all principal items of equipment furnished. This material shall be bound as a volume of the "Record and Information Booklet" complete with electronic copy as hereinafter specified.

- E. All lines (piping) installed under this contract shall be stenciled with "direction of flow" arrows and with stenciled letters naming each pipe and service.
- F. Provide at least 8 hours of straight time instruction to the operating personnel. This instruction period shall consist of not less than one (1) consecutive 8-hour day. Time of instruction shall be designated by the Owner. All instruction periods shall be video-taped, DVD or external hard drive format. Turn two (2) copies of disks over to the Owner after successful demonstration and training.

3.14 WALL AND FLOOR PENETRATION:

- A. All penetrations of partitions, ceilings, and floors by piping or conduit under Division 22 shall be sealed and caulked airtight for sound and air transfer control and/or fire stopped for fire walls and floors.

3.15 RECORD DRAWINGS:

- A. Upon completion of the plumbing installations, the Contractor shall deliver to the Architect one complete set of the plumbing contract drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings. Additionally the contractor shall provide an electronic copy of the record drawings.

3.16 GUARANTEE:

- A. Contractor's attention is directed to guarantee obligations contained in the GENERAL CONDITIONS.
- B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of guarantee shall be included in the operations and maintenance manuals.
- C. Contractor shall also provide, when due to malfunction, one (1) year free service, from the time of final acceptance by the Owner, to keep the equipment in operating condition. This service shall be rendered upon request when notified of any equipment malfunctions.
- D. All refrigeration compressors shall be provided with a five (5) year parts and labor warranty, including replacement of refrigerant.

3.17 LUBRICATION

- A. All bearings, motors, and all equipment requiring lubrication shall be provided with accessible fittings for same. Before turning over the equipment to the Owner, the Contractor shall fully lubricate each item of equipment, shall provide one year's supply of lubricant for each, and shall provide Owner with complete written lubricating instructions, together with diagram locating the points requiring lubrication. Include this information in the Record and Information Booklet.
- B. In general, all motors and equipment shall be provided with grease lubricated roller or ball bearings with Alemite or equal accessible or extended grease fittings and drain plugs.

- C. Provide pressure relief fittings at all grease lubrication locations designed to automatically vent within the range of 1/4 to 1 psi, automatically reset below this range, or another pressure relief range if the preceding differs from the manufacturer's recommended pressure range.

3.18 RECORD AND INFORMATION BOOKLET:

- A. The Contractor shall have prepared three (3) copies of the Record and Information Booklet and deliver these copies of the booklet to the Owner. The booklet shall be as specified herein. The booklet must be approved and will not be accepted as final until so stamped.
- B. The booklet shall be bound in a three-ring loose-leaf binder similar to "National" No. 3881 with the following title lettered on the front: "Record and Information Booklet (insert name of the project)". No sheets larger than 8-1/2" x 11" shall be used, except sheets that may be neatly folded to 8-1/2" x 11" and used as a pull-out.
- C. All booklet information shall also be provided in electronic format, PDF files, stored on a CD or DVD. Each binder shall contain an envelope sleeve containing the electronic format media (CD's or DVD's).
- D. Provide the following data in the booklet:
 - 1. Catalog data on each piece of plumbing equipment furnished.
 - 2. Maintenance operation and lubrication instructions on each piece of equipment furnished.
 - 3. Complete catalog data on each piece of plumbing equipment furnished, including approved shop drawings.
 - 4. Manufacturer's and Contractors' guarantees.
 - 5. Chart form indicating time and type of routine maintenance of plumbing equipment. The chart shall also indicate tag number, model number of equipment, location and service. For replacement items such as filters, indicate type, size and quantity of the replaceable items.
 - 6. Provide sale and service representatives' names and phone numbers of all equipment and subcontractors.
 - 7. Catalog data of all equipment valves, etc., which shall include wiring diagrams, parts list and assembly drawing.
 - 8. Provide valve chart including valve tag number, valve type, valve model number, valve manufacturer, style, service and location, etc., as specified hereinafter.
 - 9. Provide certification that lead-free and asbestos-free products were provided.
 - 10. Provide operating curves indicating design and balanced conditions for pumps.
 - 11. Provide copies of all flushing reports.
 - 12. Provide copies of all start-up reports.
 - 13. DVD's of all demonstration and instructional periods.
 - 14. CD's/DVD's of all coordination drawings.

3.19 TESTS, GENERAL:

- A. The entire new plumbing systems shall be tested hydrostatically for a duration of four (4) hours before insulation covering is applied and provided tight under the following gauge pressures:
 - 1. Domestic Water & Coil Drain Piping: 100 psi
 - 2. Sanitary & Storm Water Piping as specified below
 - 3. Sanitary & Storm Water Piping as specified below
 - 4. Natural Gas: 100 psi
- B. All storm, waste, vent and water piping shall be tested by the Contractor and approved by the Engineer and local code official before acceptance. All storm, soil, and waste piping, located

underground, shall be tested before backfilling. The costs of all equipment required for tests are to be included under the contract price.

- C. The entire new drainage system and venting system shall have all necessary openings plugged and filled with water to the level of the highest stack above or at the roof. The system shall hold this water for thirty (30) minutes without showing a drop greater than 1". Where a portion of the system is to be tested, the test shall be conducted in the same manner as described for the entire system, except a vertical stack 10 feet above the highest horizontal line to be tested may be installed and filled with water to maintain sufficient pressure, or a pump may be used to supply the required pressure. The pressure shall be maintained for thirty (30) minutes.
- D. Upon completion of roughing-in and before setting fixtures, the entire new water piping system shall be tested at a hydrostatic pressure of not less than one hundred (100) pounds per square inch gauge and proved tight at this pressure. Where a portion of the water piping system is to be concealed before completion, this portion shall be tested separately in a manner described for the entire system.
- E. All testing shall be witnessed by local code official and Warrior Run School District. The Contractor shall provide a minimum of 48-hour notice before testing. The Contractor shall coordinate with and get approval from the Warrior Run School District.
- F. Gas Testing:
 - 1. Before any section of a gas piping system is put into service, it shall be carefully tested to assure that it is gastight. Prior to testing, the system shall be blown out, cleaned, and cleared of all foreign material. Each joint shall be tested by means of an approved gas detector, soap and water, or an equivalent nonflammable solution. Testing shall be completed before any work is covered, enclosed, or concealed. All testing of piping system shall be done with due regard for the safety of employees and the public during the test. All testing and purging shall comply with local utility company requirements. Bulkheads, anchorage and bracing suitably designed to resist test pressures shall be installed if necessary. Oxygen shall not be used as a testing medium.
 - 2. Pressure Tests: Before appliances are connected, piping systems shall be filled with air or an inert gas and shall withstand a minimum pressure of 3 pounds gauge for a period of not less than 10 minutes as specified in NFPA 54 without showing any drop in pressure. Oxygen shall not be used. Pressure shall be measured with a mercury manometer, slope gauge, or an equivalent device so calibrated as to be read in increments of not greater than 0.1 pound. The source of pressure shall be isolated before the pressure tests are made.
 - 3. Test with Gas: Before turning gas under pressure into any piping, all openings from which gas can escape shall be closed. Immediately after turning on the gas, the piping system shall be checked for leakage by using a laboratory-certified gas meter, an appliance orifice, a manometer, or equivalent device. All testing shall conform to the requirements of NFPA 54. If leakage is recorded, the gas supply shall be shut off, the leak shall be repaired, and the tests repeated until all leaks have been stopped.
 - 4. Purging: After testing is completed, and before connecting any appliances, all gas piping shall be fully purged. Piping shall not be purged into the combustion chamber of an appliance. The open end of piping systems being purged shall not discharge into confined spaces or areas where there are ignition sources unless the safety precautions recommended in NFPA 54 are followed.
 - 5. Labor, Materials, and Equipment: All labor, materials, and equipment necessary for conducting the testing and purging shall be furnished by the Contractor.

3.20 LINTELS:

- A. Under this Section, provide lintels not provided elsewhere which are required for openings for the installation of plumbing work. Lintels shall meet the requirements of the Architectural and Structural Sections and The Architectural Drawings and Specifications.

3.21 EQUIPMENT BY OTHERS

- A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions. Connections shall be complete in all respects to render this equipment functional to its fullest intent.
- B. It shall be the responsibility of the supplier of this equipment to furnish complete instructions for connections.
- C. Typical equipment refers to, but is not limited to: Kiln hoods, storage cabinets and all other kitchen equipment.

3.22 FASTENERS:

- A. All fasteners located in public space, including classrooms, offices, etc., shall be provided with tamper-proof type fasteners where specifically indicated.

3.23 WIRING DIAGRAMS

- A. Obtain and submit wiring diagrams for all equipment provided under this Contract.
- B. Wiring diagrams shall be provided with Shop Drawings for similar to, but not limited to, the following:
 - 1. All equipment.
- C. The Contractor shall submit any additional wiring diagrams as requested by the Engineer.
- D. Provide wiring diagrams and identify all termination points, connections, and interface points for all major mechanical equipment to the Electrical Contractor and the ATC Subcontractor for coordination.

3.24 INSTALLATION AND COORDINATION DRAWINGS;

- A. Prepare, submit, and use composite installation and coordination drawings to assure proper coordination and installation of work. Drawings shall include, but not be limited, to the following: Complete Ductwork, Plumbing, Sprinkler and HVAC Piping Drawings showing coordination with approved equipment, approved casework drawings, lights, electrical equipment and structural. The Mechanical Contractor is responsible for coordinating with all trades to insure systems will fit in the available space. If conflicts exist after fabrication and/or installation of systems prior to preparing a coordinated drawing of the area, the Contractor shall remove, re-fabricate, and re-install all such work at their own cost, except for the difference in cost, if any, from the originally designed system to the revised design. If no design changes were made, and clarifications were required, it shall be at no expense to the Owner.

- B. Draw plans to a scale not less than 3/8-inch equals one foot. Include plans, sections, and elevations of proposed work, showing all equipment, piping and ductwork in areas involved. Fully dimension all work including hoods, casework and associated utilities, valve boxes, lighting fixtures, conduits, pullboxes, panelboards, and other electrical work, telecommunications equipment, walls, doors, ceilings, columns, beams, joists and other architectural and structural work. Division 23 shall coordinate the development of composite coordination drawings.
- C. Identify all equipment and devices on wiring diagrams and schematics. Where field connections are shown to factory-wired terminals, include manufacturer's literature showing internal wiring.
- D. All coordination drawings shall be prepared in AutoCAD or Revit format and submitted in color. Different colors shall be used to determine different building components. In addition to the composite coordination drawings, simultaneously submit individual sheet-metal, piping, plumbing and sprinkler coordination drawings.
- E. The Mechanical Contractor shall schedule bi-weekly Coordination Drawing Reviews with the Owner, Mechanical Engineer, and all associated subcontractors, including but not limited to the following:
 - 1. Mechanical Contractor
 - 2. Finishes Contractor
 - 3. Sheet Metal Contractor
 - 4. Sprinkler Contractor
 - 5. Electrical Contractor
 - 6. Plumbing Contractor
 - 7. Owner/Architect/Engineer
 - 8. Note: A Foreman or Project Manager responsible for Decision-Making of each company shall attend all Coordination Meetings.
- F. The purpose of these meetings is to coordinate proposed installations of systems and equipment, including clearances, routing, penetrations, as well as to review potential conflicts. The Mechanical Contractor shall base preliminary equipment sizes and connections on proposed products and the final coordination drawing for review shall reflect approved/reviewed products. Coordination Meetings shall be held at the Contractor's Field Office.

3.25 BOILER AND PRESSURE VESSELS

- A. All boilers and pressure vessels shall be ASME-rated and shall comply with the State of Pennsylvania, latest requirements.
- B. Provide all control devices and materials, and install in with ASME CSD-1 controls and safety devices for automatically fired boilers.

3.26 FACTORY START-UP

- A. Provide factory authorized start-up service for all plumbing equipment. Coordinate with the Commissioning Agent.
- B. Provide one copy of all start-up reports to the Owner and include a copy in the O&M Manual.

- C. Tempering Valves: Provide factory-authorized individual to review installation and develop a report to submit to the Engineer. Report submission shall be prior to Engineer's Punch-Out and Demonstration/Training.
- D. The Contractor shall be required to start up all systems in an orderly, organized, and coordinated manner to ensure that all systems are functioning as designed. The Contractor shall provide a detailed start-up, testing and demonstration plan for all systems in a coordinated manner that is documented in writing at least forty-five (45) days prior to start-up. Start-up, testing, and demonstration plans shall include detailed point-by-point check list that clearly shows that systems are in face functioning as designed. The A/E shall include modifications to the standard AIA definition of substantial completion to indicate that Mechanical/Electrical Systems are not substantially complete until all systems are started, tested, balanced, and O&M Manuals are received by the Owner. Above listed items must be completed in time to allow for system demonstrations to Owner Personnel with all O&M Manuals in hand at the time of demonstration. Contractors will be required to provide system demonstrations and training for Owner Personnel for each system. At minimum, the Contractors shall provide eight (8) hours of demonstration and eight (8) hours of systems operation training for each system prior to Owner acceptance of any given system.

3.27 PLUMBING INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of plumbing systems, materials, and equipment including, but not limited to, the following:
 - 1. Coordinate plumbing systems, equipment and materials installation with other building components.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - 5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 - 6. Where mounting heights are not detailed, noted, or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - 7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
 - 8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form.
 - 9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished space.
 - 10. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of equipment components in accordance with manufacturers' recommendations. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
 - 11. Install access panels or doors where units are concealed behind finished surfaces.
 - 12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
 - 13. Install above-ceiling equipment requiring servicing and/or maintenance within 48" of accessible ceilings/access panels.
 - 14. Test and balance the domestic hot water/hot water recirculation system.

15. Where different pipe sizes are indicated on the Drawings, the largest pipe size shall be used for the basis of the Bid.

3.28 SCHEDULING OF WORK AND OUTAGES

- A. All required outages shall be coordinated with and approved by the Owner a minimum of fourteen (14) days in advance. Written notice of not less than fourteen (14) calendar days shall precede any outage. The Contractor shall include in their bid outages and/or work in occupied areas to occur during weekends, holidays, or at night. No outages are allowed during school hours.
- B. All temporary utilities shall be provided by and paid for by the Contractor. All utilities serving the existing building(s) shall be maintained; or temporary piping, equipment, etc., shall be provided so as not to affect the normal function and operation of the building and its systems. Coordinate these requirements with the Owner.

END OF SECTION 22 05 00

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING 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. Thermal-hanger shield inserts.
 - 4. Fastener systems.
 - 5. Pipe stands.
 - 6. Pipe positioning systems.
 - 7. Equipment supports.

- B. Related Sections:

- 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 21 fire-suppression piping Sections for pipe hangers for fire-suppression piping.
 - 3. Division 22 Section "Vibration Controls for Plumbing Piping and Equipment" for vibration isolation devices.

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.
- B. Structural Performance: Hangers and supports for plumbing 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 test 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.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. 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 cadmium plated or stainless steel.
- B. Copper Pipe Hangers:
 1. Description: MSS SP-58, Types 1 through 58, copper-clad hanger, factory-fabricated components.
 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of cadmium plated or stainless 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 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Clement Support Services.

2. ERICO International Corporation.
3. National Pipe Hanger Corporation.
4. PHS Industries, Inc.

- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless-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.

2.5 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. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
- C. Curb-Mounting-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. Supports shall be hot-dipped galvanized construction. All fasteners, washers, etc., shall be stainless steel.

2.6 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.7 EQUIPMENT SUPPORTS

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

2.8 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black (painted) and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi (34.5-MPa), 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 powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. 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. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. 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. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. 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.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. 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 (DN 65) 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.
- M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe hangers and supports shall be attached to the panel point at the top chord of bar joist or at a location approved by the structural engineer. Do not support all parallel piping from the same bar joist (4" pipe and larger) unless approved by structural engineer.
- O. 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.
- P. 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 (DN 100) and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, 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 (DN 100) 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 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
 - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
- 5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. 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 (40 mm).

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. 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 galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use copper or copper clad attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use painted or galvanized carbon-steel pipe hangers and supports and metal framing systems and attachments for general service applications. Use stainless steel pipe hangers and attachments for exterior applications.
- F. Use thermal-hanger shield inserts for insulated piping and tubing.
- G. 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 noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
 2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
 3. Adjustable Roller Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - a. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 - b. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
- H. 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 (DN 24 to DN 600).
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
- I. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
 2. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
- J. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape at the panel point.
 2. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 3. Side Beam Clamps (MSS Type 27): For bottom of steel I-Beams.
- K. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- L. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system sections.
- M. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system sections.
- N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply waste piping for plumbing fixtures.

END OF SECTION 22 05 29

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING 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. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 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. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number based on PM Identification System of the school district, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) 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, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Black.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

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

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

- I. 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, snap-on semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive (4" and less). For larger pipe (sizes 6" and greater) markers shall be strapped around using nylon ties.
- C. 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: At least 1-1/2 inches (38 mm) high.

2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME (ANSI) A13.1 for piping; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: Fiberboard or metal.
 - 2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, alkyd enamel in colors according to ASME (ANSI) A13.1 unless otherwise indicated.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) black-filled letters for piping system abbreviation and 1/2-inch (13-mm) black-filled numbers, 2-inch diameter.
 - 1. Tag Material: Brass, 19 gauge minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass jack chain.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) 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 (100 by 178 mm).
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

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 Division 09.
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME (ANSI) A13.1, on each piping system.
 1. Identification Paint: Use for contrasting background.
 2. Stencil Paint: Use for pipe marking.
- C. 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 along each run. Reduce intervals to 15 feet (7.6 m) in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
 8. Where pipes are adjacent to each other, markings shall be neatly lined up. All markings shall be located in such a manner to be easily legible from the floor.
 9. For piping less than 3/4 inch, provide permanently legible tag as specified hereinbefore for valve identification.
 10. For buried piping, provide 2-inch minimum width with plastic identification/detection tape with metallic core. Install 4 to 6-inches below-grade.

D. Pipe Label Color Schedule:

1. Natural Gas:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.
2. Domestic Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
3. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.

3.4 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 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. Cold Water: 2 inches (50 mm), round.
 - b. Hot Water: 2 inches (50 mm), round.
 - c. Natural Gas: 2 inches (50 mm), round.
 2. Valve-Tag Color:
 - a. Cold Water: Natural.
 - b. Hot Water: Natural.
 - c. Natural Gas: Natural.
 3. Letter Color:
 - a. Cold Water: Black.
 - b. Hot Water: Black.
 - c. Natural Gas: Black.

3.5 WARNING-TAG INSTALLATION

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

END OF SECTION 22 05 53

SECTION 22 07 00

PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Insulation Materials:
 - a. Calcium silicate.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
- 2. Insulating cements.
- 3. Adhesives.
- 4. Mastics.
- 5. Lagging adhesives.
- 6. Sealants.
- 7. Factory-applied jackets.
- 8. Field-applied fabric-reinforcing mesh.
- 9. Field-applied cloths.
- 10. Field-applied jackets.
- 11. Tapes.
- 12. Securements.
- 13. Corner angles.

- B. Related Sections include the following:

- 1. Division 23 Section "HVAC Insulation."

1.3 SUBMITTALS

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

- B. Shop Drawings:

- 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
- 2. Detail attachment and covering of heat tracing inside insulation.
- 3. Detail insulation application at pipe expansion joints for each type of insulation.
- 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

5. Detail field application for each equipment type.

C. Qualification Data: For qualified Installer.

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

E. Field quality-control reports.

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

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

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

1.5 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 size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment 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.

C. Coordinate installation and testing of heat tracing.

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.

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Calcium Silicate:
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Owens-Corning.
 - b. Johns Mansville.
 - 2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 3. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Johns Mansville.
 - b. Armacell LLC; AP Armaflex.
 - c. Aeroflex USA, Inc.; Aerocel.
 - d. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- H. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000(Pipe Insulation.
 - c. Owens Corning; Fiberglas Pipe Insulation.
 - 2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied

ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

- I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. 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.; CrimpWrap.
- b. Johns Manville; MicroFlex.
- c. Knauf Insulation; Pipe and Tank Insulation.
- d. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Insulco, Division of MFS, Inc.; Triple I.
- b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

2.3 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 (10 to 427 deg C).

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Products, Division of ITW; CP-97.
- b. Foster Products Corporation, H. B. Fuller Company; 81-27/81-93.
- c. Marathon Industries, Inc.; 290.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- C. 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 Products, Division of ITW; CP-82.
- b. Foster Products Corporation, H. B. Fuller Company; 85-20.
- c. ITW TACC, Division of Illinois Tool Works; S-90/80.
- d. Marathon Industries, Inc.; 225.
- e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 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 Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Speedline Vinyl Adhesive.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. ITW TACC, Division of Illinois Tool Works; CB-50.
 - d. Marathon Industries, Inc.; 590.
 - e. Mon-Eco Industries, Inc.; 55-40.
 - f. Vimasco Corporation; 749.
 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-30.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-35.
 - c. ITW TACC, Division of Illinois Tool Works; CB-25.
 - d. Marathon Industries, Inc.; 501.
 - e. Mon-Eco Industries, Inc.; 55-10.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
3. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. 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 Products, Division of ITW; Encacel.
 - b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
 - c. Marathon Industries, Inc.; 570.
 - d. Mon-Eco Industries, Inc.; 55-70.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

E. 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 Products, Division of ITW; CP-10.
 - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
 - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
 - d. Marathon Industries, Inc.; 550.
 - e. Mon-Eco Industries, Inc.; 55-50.
 - f. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F 1249, 3 perms (2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F (Minus 29 to plus 93 deg C).
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.5 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 250 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 Products, Division of ITW; CP-52.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-42.
 - c. Marathon Industries, Inc.; 130.
 - d. Mon-Eco Industries, Inc.; 11-30.
 - e. Vimasco Corporation; 136.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
4. Service Temperature Range: Minus 50 to plus 180 deg F (Minus 46 to plus 82 deg C).
5. Color: White.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76-8.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Vimasco Corporation; 750.
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 (Minus 40 to plus 121 deg C).
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. 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 Products, Division of ITW; 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 (Minus 40 to plus 121 deg C).
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

a. Products: Subject to compliance with requirements, provide the following:

- 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

5. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

a. Products: Subject to compliance with requirements, provide the following:

- 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

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

a. Products: Subject to compliance with requirements, provide the following:

- 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

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. (271 g/sq. m).

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.9 FIELD-APPLIED JACKETS

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

- B. 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. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC 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.
 - 5. Factory-fabricated tank heads and tank side panels.
- C. Metal Jacket:
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - 2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) 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.
- D. Underground Direct-Buried Jacket: 125-mil- (3.2-mm-) thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pittsburgh Corning Corporation; Pittwrap.
 - b. Polyguard; Insulrap No Torch 125.

2.10 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. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
- b. Compac Corp.; 104 and 105.
- c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
- d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

- 2. Width: 3 inches (75 mm).
- 3. Thickness: 11.5 mils (0.29 mm).
- 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
- 5. Elongation: 2 percent.
- 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) 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. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
- b. Compac Corp.; 110 and 111.
- c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
- d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

- 2. Width: 3 inches (75 mm).
- 3. Thickness: 6.5 mils (0.16 mm).
- 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
- 5. Elongation: 2 percent.
- 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
- 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
- b. Compac Corp.; 130.
- c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
- d. Venture Tape; 1506 CW NS.

- 2. Width: 2 inches (50 mm).
- 3. Thickness: 6 mils (0.15 mm).
- 4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
- 5. Elongation: 500 percent.
- 6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - b. Compac Corp.; 120.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
 - d. Venture Tape; 3520 CW.
 - 2. Width: 2 inches (50 mm).
 - 3. Thickness: 3.7 mils (0.093 mm).
 - 4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
 - 5. Elongation: 5 percent.
 - 6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.
- E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.
- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
 - 2. Width: 3 inches (75 mm).
 - 3. Film Thickness: 6 mils ((0.15 mm)).
 - 4. Adhesive Thickness: 1.5 mils (0.04 mm).
 - 5. Elongation at Break: 145 percent.
 - 6. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

2.11 SECUREMENTS

A. Bands:

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
- 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch (0.38 mm) thick, 3/4 inch (19 mm) wide with wing or closed seal.
- 3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm) wide with wing 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- (3.5-mm-) 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- (3.5-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; CWP-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 Insul-Hangers, Series T.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
 - c. Spindle: Stainless steel, fully annealed, 0.106-inch- (2.6-mm-) 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. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
 - c. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, provide one of the following:

- 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
 - 2) GEMCO; Press and Peel.
 - 3) Midwest Fasteners, Inc.; Self Stick.
- b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
 - c. Spindle: Stainless steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) 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.
 7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) GEMCO.
 - 2) Midwest Fasteners, Inc.
 - C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.
 - D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & F Wire.
 - b. Childers Products.
 - c. PABCO Metals Corporation.
 - d. RPR Products, Inc.

2.12 CORNER ANGLES

- A. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- B. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel accord.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). 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 (50 mm) o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to 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 (100 mm) 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 (50 mm) below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. 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 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 3. Protect exposed corners with secured corner angles.
 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.
 7. Stagger joints between insulation layers at least 3 inches (75 mm).
 8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
 2. Seal longitudinal seams and end joints.

3.6 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.8 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

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

3.9 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

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

3.10 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch (50-mm) 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 (300 mm) o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presizes jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches (50 mm) over the previous section. Adhere lap seal using

- adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
 4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. The 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
 5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.11 FINISHES

- A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- 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.

3.12 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 field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.13 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- C. Domestic cold-water storage tank insulation shall be the following, of thickness to provide an R-value of 12.5:
 - 1. Mineral-Fiber Board: 3-lb/cu. ft. (48-kg/cu. m) nominal density.

3.14 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. Underground piping.

3.15 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 - 1. Two-inch (2") pipe size and Smaller: Insulation shall be the following:
 - a. Molded fiberglass 1/2 inch thick.
 - 2. Two-and-one-half-inch (2-1/2") pipe size and Larger: Insulation shall be the following:
 - a. Molded fiberglass 1-inch thick.
 - 3. Half-inch (1/2") run-out piping: Insulation shall be one of the following:
 - a. Molded fiberglass 1/2-inch thick.
 - b. Flexible Elastomeric: 1/2 inch (13 mm) thick.
- B. Domestic Hot and Recirculated Hot Water:
 - 1. One-and one-quarter-inch (1-1/2") pipe size and Smaller: Insulation shall be the following:
 - a. Molded fiberglass 1-inch thick.
 - 2. One and one-half-inch (1-1/2") and Larger: Insulation shall be the following:
 - a. Molded fiberglass 1-1/2 inch thick.
 - 3. Half-inch (1/2") run-out piping: Insulation shall be one of the following:
 - a. Molded fiberglass 1-inch thick.
 - b. Flexible Elastomeric: 1 inch (25 mm) thick.
- C. Stormwater and Overflow:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Molded fiberglass 1-inch thick.

D. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch (25 mm) thick.
 - b. Molded fiberglass 1-inch thick.

E. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):

1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch (25 mm) thick.
 - b. Molded fiberglass 1-inch thick.

F. Exposed Sanitary Drains, domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be Truebro Lav Guard – ADA approved undersink pipe insulation cover system. Refer to Section 224000 for additional information on protective shielding guards.

G. Floor Drains, Traps, and Sanitary Drain Piping within 10 feet (3m) of drain receiving condensate and equipment drain water below 60 degrees F (16 degrees C):

1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-inch (25 mm) thick.

H. Hot Service Drains:

1. All Pipe Sizes: Insulation shall be the following: Mineral-Fiber, Preformed Pipe, Type I or II: 1-inch (25 mm) thick.

I. Hot Service Vents:

1. All Pipe Sizes: Insulation shall be the following: Mineral-Fiber, Preformed Pipe, Type I or II: 1-inch (25 mm) thick.

J. Piping with Heat Trace:

1. All pipe sizes (exterior condensate drain and refrigerator/freezer condensate drain piping): Insulation shall be the following: Mineral-Fiber, Preformed Pipe, Type I or II: 1-inch (25 mm) thick.

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

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

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

C. Equipment, Exposed, up to 48 inches (1200 mm) in Diameter or with Flat Surfaces up to 72 inches (1800 mm):

1. PVC: 30 mils (0.8 mm) thick.

D. Equipment, Exposed, Larger than 48 inches (1200 mm) in Diameter or with Flat Surfaces Larger than 72 inches (1800 mm):

1. Aluminum with 0.040 inch (1.0 mm) thick.

E. Piping, Concealed:

1. None.

- F. Piping, Exposed (including mechanical rooms, occupied areas) and/or Heat Traced:
1. Indoor PVC: 20 mils (0.5 mm) thick, Green with White lettering for identification).
 2. Exterior – Aluminum: 0.040 inch thick.

END OF SECTION 22 07 00

SECTION 22 13 16
SANITARY WASTE AND VENT 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 the following for soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.
 - 3. Encasement for underground metal piping.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. LLDPE: Linear, low-density polyethylene plastic.
- D. NBR: Acrylonitrile-butadiene rubber.
- E. PE: Polyethylene plastic.
- F. PVC: Polyvinyl chloride plastic.
- G. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: (Type DWV) ASTM D 2665, drain, waste, and vent.
 - 1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.
- B. Solvent Cement and Adhesive Primer:
 - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 HUB-LESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.
- C. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 1. Heavy-Duty, Husky Type, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.

a. Available Manufacturers:

- 1) ANACO.
- 2) Clamp-All Corp.
- 3) Ideal Div.; Stant Corp.
- 4) Mission Rubber Co.
- 5) Tyler Pipe; Soil Pipe Div.
- 6) Charlott.

D. Rigid, Unshielded Couplings: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Available Manufacturers:

a. ANACO.

2.5 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
2. Copper Condensate Drain Piping: Type L, drawn copper tubing, wrought copper fittings and soldered joints.

2.6 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

- a. Fernco, Inc.
- b. Logan Clay Products Company (The).
- c. NDS, Inc.
- d. Plastic Oddities, Inc.

2. Sleeve Materials:

- a. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
- b. For cast iron soil pipes: ASTM C564 rubber.
- c. For dissimilar pipes: ASTM D 1460, elastomeric or rubber sleeve with full length, corrosion-resistant outer shield and corrosion-resistant metal tension band and tightening mechanism on each end.

B. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Manufacturers:

- a. EBAA Iron Sales, Inc.
- b. Romac Industries, Inc.
- c. Star Pipe Products; Star Fittings Div.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground, soil and waste piping shall be the following:
 - 1. Hubless cast iron soil pipe and fittings; heavy duty (husky) shielded stainless steel couplings and hubless coupling joints.
- C. Aboveground, vent piping shall be the following:
 - 1. Hubless cast iron soil pipe and fittings; heavy duty (husky) shielded stainless steel couplings and hubless coupling joints.
- D. Underground, soil, waste, and vent piping NPS 6 and smaller shall be the following:
 - 1. Solid wall, Sewer and Drain Series, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints except for kitchen.
 - 2. Service class cast iron soil piping with gasketed or caulked joints for all kitchen sanitary lines connected to the grease trap.
- E. Above-ground, soil, and waste and vent piping located over the kitchen, cafeteria/dining area (including ancillary spaces) and other food preparation/eating areas shall be the following:
 - 1. Copper DWV tube, copper drainage fittings and soldered joints.
- F. All Condensate Drain Piping:
 - 1. Type L, drawn copper tubing with wrought copper fittings and soldered joints.
 - 2. Solid wall PVC pipe.

3.3 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- C. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and fittings Handbook" Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- D. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with

common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

- E. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- F. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- G. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- H. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- I. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- J. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- K. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- L. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- M. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.
- C. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- D. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 VALVE INSTALLATION

- A. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
- B. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
 - 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated. Provide full-sized manhole to grade/finished floor.
 - 2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
 - 3. Install backwater valves in accessible locations.
 - 4. Backwater valve are specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Install individual, straight, horizontal piping runs according to the following:
 - a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
 - 3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
 - 4. NPS 6 (DN 150): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
 - 5. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
- F. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.

2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
 3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
 4. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
 5. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
 6. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
- H. Install supports for vertical copper tubing every 10 feet (3 m).
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.9 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 22 13 16

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

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 the following sanitary drainage piping specialties:
 - 1. Backwater valves.
 - 2. Cleanouts.
 - 3. Floor drains.
 - 4. Trench drains.
 - 5. Roof flashing assemblies.
 - 6. Through-penetration firestop assemblies.
 - 7. Miscellaneous sanitary drainage piping specialties.
 - 8. Flashing materials.
- B. Related Sections include the following:
 - 1. Division 22 Section "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:

1. Drains.
2. Backwater valves.
3. Solids Interceptors.

1.5 **QUALITY ASSURANCE**

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. 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.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 **COORDINATION**

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 **BACKWATER VALVES**

- A. Horizontal, Cast-Iron Backwater Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Standard: ASME A112.14.1.
 3. Size: Same as connected piping.
 4. Body: Cast iron.
 5. Cover: Cast iron with bolted access check valve.
 6. End Connections: Hubless.
 7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
 8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

2.2 CLEANOUTS

- A. Exposed Metal Cleanouts – Unfinished areas:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 4228 Series or a comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 - g. Josam Company; Blucher-Josam Div.
 2. Standard: ASME A112.3.1 for stainless steel for cleanout test tee.
 3. Size: Same as connected drainage piping
 4. Body Material: Stainless-steel tee with side cleanout as required to match connected piping.
 5. Closure: Countersunk brass plug.
 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 7. Closure: Stainless-steel plug with seal.
- B. Metal Floor Cleanouts:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Series 4188C (terrazzo-recessed); Series 4168C (composition tile – recessed); Series 4048C (ceramic tile – non-recessed) and Series 4026C-Y (carpet with clean-out marker) or a comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Zurn Plumbing Products Group.
 2. Standard: ASME A112.36.2M for cast-iron soil pipe with cast-iron ferrule cleanout.
 3. Size: Same as connected branch.
 4. Type: Cast-iron soil pipe with cast-iron ferrule.
 5. Body or Ferrule: Cast iron.
 6. Clamping Device: Not required.
 7. Outlet Connection: Inside calk.
 8. Closure: Brass plug with tapered threads.
 9. Adjustable Housing Material: Cast iron with threads.
 10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
 11. Frame and Cover Shape: Round, Square, or as determined by floor type.
 12. Top Loading Classification: Heavy Duty.
 13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
- C. Wall Cleanouts:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Series 5432 (unfinished areas, Series 4558 (plaster/drywall) and Series 4532 (tile/CMU) or a comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.

- e. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.36.2M. Include wall access.
- 3. Size: Same as connected drainage piping.
- 4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
- 5. Closure: Countersunk brass plug.
- 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- 7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
- 8. Wall Access: Square, stainless-steel wall-installation frame and cover. Refer to Series type.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains – FD-A:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide J. R. Smith Series 2230 or a comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.6.3.
- 3. Pattern: Floor drain.
- 4. Body Material: Gray iron.
- 5. Seepage Flange: Not required.
- 6. Anchor Flange: Required.
- 7. Clamping Device: Required.
- 8. Outlet: Bottom.
- 9. Backwater Valve: Not required.
- 10. Coating on Interior and Exposed Exterior Surfaces: Not required.
- 11. Sediment Bucket: Not required
- 12. Top or Strainer Material: Galvanized cast iron.
- 13. Top Shape: Square.
- 14. Dimensions of Top or Strainer: 5" Square.
- 15. Top Loading Classification: Medium Duty.
- 16. Funnel: Required, where receiving piped waste.
- 17. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
- 18. Trap Material: Cast iron.
- 19. Trap Pattern: Deep-seal P-trap.
- 20. Trap Features: Not required.

B. Cast-Iron Floor Drains – FD-B:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide J. R. Smith Series 2005 or a comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASME A112.6.3.
- 3. Pattern: Floor drain.
- 4. Body Material: Gray iron.

5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Backwater Valve: Not required.
10. Coating on Interior and Exposed Exterior Surfaces: Not required.
11. Sediment Bucket: Not required.
12. Top or Strainer Material: Nickel bronze.
13. Top of Body and Strainer Finish: Nickel bronze.
14. Top Shape: Round; or square where installed in tile floors.
15. Dimensions of Top or Strainer: 6" Round; or square where installed in tile floors.
16. Funnel: Not required.
17. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
18. Trap Material: Not required.
19. Trap Pattern: Deep-seal P-trap.
20. Trap Features: Not required.

2.4 TRENCH DRAIN

- A. Plastic Channel Drainage Systems:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide J.R. Smith Enviro-Flo Series 9930 with load Class A light Duty Grate Series 9870-451-SSPA, or a comparable product by one of the following:
 - a. Zurn Plumbing Products Group; Flo-Thru Operation.
 - b. Josam Company.
 2. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 - a. Channel Sections: Interlocking-joint, HDPE or PE, modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated. Dimensions: 4 inches (102 mm) wide. Include number of units required to form total lengths indicated.
 - b. Grates: With perforations and widths and thickness that fit recesses in channel sections. Material: Perforated stainless steel with quick-lock assembly.
 - c. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
 - d. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.5 ROOF FLASHING ASSEMBLIES

- A. Roof Flashing Assemblies:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.
 - c. All American Metal Products, Inc.
- B. Description: EPDM base seal and skirt extending at least 18 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting. Provide 20-year warranty against leaks, condensation, and defects in materials and/or manufacturing.

- C. Roof flashing shall be installed by the Roofing Contractor.

2.6 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. 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:
 - a. ProSet Systems Inc.
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

2.7 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains – (OHD):

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.
3. Open hub drain shall be Josam 67100A Series coated cast iron with ball float, 1-1/2" trap priming connection, or comparable product of J.R. Smith, Zurn, or WaDE.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
 - a. NPS 2 (DN 50): 4-inch- (100-mm-) minimum water seal.
 - b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

D. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches (51 mm) above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

E. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

F. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

G. Odor Reducing Vent Cap:

1. Description: ABS DWV body and PVC hooded dome cap with vapor phase virgin pelletized activated carbon in fiberglass mesh replaceable bag.
2. Size: Same as vent piping.
3. Model: Sweet Air model VS-TT.

2.8 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm) thickness.
2. Vent Pipe Flashing: 8 oz./sq. ft. (2.5 kg/sq. m or 0.27-mm) thickness.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.

3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor and 30"x30" flashing.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
 - b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
 - c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.
 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- G. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- H. Assemble and install ASME A112.3.1, stainless-steel channel drainage systems according to ASME A112.3.1. Install on support devices so that top will be flush with surface.
- I. Assemble non-ASME A112.3.1, stainless-steel channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- J. Assemble FRP channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- K. Assemble plastic channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- L. Install fixture air-admittance valves on fixture drain piping.
- M. Install stack air-admittance valves at top of stack vent and vent stack piping.
- N. Install air-admittance-valve wall boxes recessed in wall. Confirm use and location with engineer prior to installation.
- O. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- P. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

- Q. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
- R. Assemble open drain fittings and install with top of hub 2 inches (51 mm) above floor.
- S. Install deep-seal traps on floor drains and other waste outlets.
- T. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- U. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- V. Install odor reducing vent caps on each vent pipe passing through roof.
- W. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.
- X. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- Y. Install wood-blocking reinforcement for wall-mounting-type specialties.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."

- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 **LABELING AND IDENTIFYING**

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Solids interceptors.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.5 **FIELD QUALITY CONTROL**

- A. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 **PROTECTION**

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

- END OF SECTION 22 13 19 -

SECTION 22 14 13
FACILITY STORM DRAINAGE 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 the following storm drainage piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.
- B. Related Sections include the following:
 - 1. Division 22 Section "Sump Pumps."

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. LLDPE: Linear, low-density polyethylene plastic.
- C. PE: Polyethylene plastic.
- D. PVC: Polyvinyl chloride plastic.
- E. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water (30 kPa).
 - 2. Storm Drainage, Force-Main Piping: 50 psig (345 kPa).

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. Solvent Cement and Adhesive Primer:
 - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 HUBLESS CAST IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 1. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
 - a. Available Manufacturers:
 - 1) ANACO.
 - 2) Clamp-All Corp.
 - 3) Ideal Div.; Stant Corp.
 - 4) Mission Rubber Co.
 - 5) Tyler Pipe; Soil Pipe Div.

6) Charlotte.

- C. Rigid, Unshielded Couplings: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Available Manufacturers:

- a. ANACO, or equal.

2.5 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

1. Copper Drainage Fittings: ASME B16.23, cast-copper or ASME B16.29, wrought-copper, solder-joint fittings.

- B. Hard Copper Tube: ASTM B 88, Types L and M (ASTM B 88M, Types B and C), water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

- C. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2.6 SPECIAL PIPE FITTINGS

- A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

- a. Dallas Specialty & Mfg. Co.
b. Fernco, Inc.
c. Logan Clay Products Company (The).

2. Sleeve Materials:

- a. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
b. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

- B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

- a. Cascade Waterworks Mfg. Co.
 - b. Mission Rubber Co.
- C. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser, Inc.; DMD Div.
 - c. EBAA Iron Sales, Inc.
 - d. Ford Meter Box Company, Inc. (The); Pipe Products Div.
 - e. JCM Industries, Inc.
 - f. Romac Industries, Inc.
 - g. Smith-Blair, Inc.
 - h. Viking Johnson.
 - 2. Gasket Material: Natural or synthetic rubber.
 - 3. Metal Component Finish: Corrosion-resistant coating or material.
- D. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - 1. Manufacturers:
 - a. EBAA Iron Sales, Inc.
 - b. Romac Industries, Inc.
 - c. Star Pipe Products; Star Fittings Div.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground storm drainage piping shall be the following:
 - 1. Hubless cast iron soil pipe and fittings; heavy duty (husky) shielded stainless steel couplings and hubless coupling joints.
 - 2. Dissimilar pipe material couplings: Rigid, unshielded non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- C. Underground storm drainage piping shall be the following:
 - 1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- D. Aboveground storm drainage force mains shall be the following:
 - 1. Hard copper tube, Type L (Type B); copper pressure fittings; and soldered joints.

3.3 PIPING INSTALLATION

- A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Utility Drainage Piping."
- B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialties."
- D. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
- E. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
- F. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- G. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- H. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 2 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
 - 2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.
- I. Install force mains at elevations indicated.
- J. Install PVC storm drainage piping according to ASTM D 2665.
- K. Install underground PVC storm drainage piping according to ASTM D 2321.
- L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Common Work Results for Plumbing."
- N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Common Work Results for Plumbing."
- O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Common Work Results for Plumbing."

- P. Install cast iron storm drainage piping for all above ground locations.

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.
- C. Hubless cast iron soil piping coupled joints; Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and fittings Handbook" for hubless-coupling joints.
- D. Soldered joints: Use ASTM B 813, water flushable, lead-free flux; ASTM B32, lead-free alloy solder; and ASTM B828 procedure, unless otherwise indicated.

3.5 VALVE INSTALLATION

- A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- B. Shutoff Valves: Install shutoff valve on each sump pump discharge.
 - 1. Install full-port ball valve for piping NPS 2 (DN 50) and smaller.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sump pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
 - 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
 - 2. Install backwater valves in accessible locations.
 - 3. Backwater valve are specified in Division 22 Section "Storm Drainage Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
 - 3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
 - 4. NPS 6 (DN 150): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
 - 5. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
 - 6. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).
- F. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
 - 3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
 - 4. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
 - 5. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
 - 6. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
- H. Install supports for vertical copper tubing every 10 feet (3 m).
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
- D. Connect force-main piping to the following:
 - 1. Sump Pumps: To sump pump discharge.

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 5. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.9 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 22 14 13

SECTION 23 05 48

VIBRATION CONTROLS 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. This Section includes the following:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Freestanding and restrained spring isolators.
 - 5. Housed spring mounts.
 - 6. Elastomeric hangers.
 - 7. Spring hangers.
 - 8. Spring hangers with vertical-limit stops.
 - 9. Pipe riser resilient supports.
 - 10. Resilient pipe guides.
 - 11. Freestanding and restrained air-mounting system.
 - 12. Restrained vibration isolation roof-curb rails.
 - 13. Seismic snubbers.
 - 14. Restraining braces and cables.
 - 15. Steel and inertia, vibration isolation equipment bases.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
 - 1. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- C. Welding certificates.
- D. Qualification Data: For engineer and testing agency.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 SUMMARY

- A. Provide all labor and materials necessary to furnish and install vibration control systems on this project as herein specified and/or shown on the drawings.
- B. Mount all mechanical equipment on suitable vibration isolators so as to prevent transmission of vibration into or through the building structure. Isolators shall be as manufactured by Mason Industries, Inc., Amber/Booth, Kenitics, or Peabody, and shall be selected by the isolator manufacturer for each item of equipment in accordance with requirements hereinafter specified.
- C. The equipment manufacturer shall supply all pump and motor bases, fan and motor bases, cradles, pipe/duct hangers, spring and/or neoprene isolators, neoprene pads, flexible connectors, etc., as a coordinated package by a single manufacturer.
- D. Select isolators for uniform static deflections according to distribution of weight; and for not less than the indicated isolation efficiency with the lowest rotational speed of equipment as the disturbing frequency.
- E. Isolators and bases shall be stable during stopping and starting of equipment without transverse or eccentric movement of equipment, and shall be designed to resist horizontal forces of equipment which may operate unbalanced.

- F. In general, select isolators on the basis of criteria as specified in the ASHRAE Applications Handbook, Latest Edition.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, or a comparable product by one of the following:
 - 1. Amber/Booth Company, Inc.
 - 2. Kinetics Noise Control.
- B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant rubber, Mason Super W.
- C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range, Mason Type No.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- D. Restrained Mounts: All-directional mountings with seismic restraint.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- E. Spring Isolators – Mason Model SLF: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
 - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- F. Restrained Spring Isolators – Mason Type SLR: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- G. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
 2. Base: Factory drilled for bolting to structure.
 3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch (6-mm) travel up or down before contacting a resilient collar.
- H. Elastomeric Hangers Mason Type HD: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
- I. Spring Hangers Mason Type 30N: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- J. Spring Hangers with Vertical-Limit Stop – Mason Type PC30N: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- K. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig (3.45 MPa) and for equal resistance in all directions.
- L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- (13-mm-) thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 THRUST RESTRAINTS

- A. Adjustable spring thrust restraints, able to resist the thrust force with at least 25 percent unused capacity. The operating spring deflection shall be not less than 50 percent of the static deflection of the isolation supporting the machinery. The spring element shall be contained within a steel frame and designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" movement at start and stop. The assembly shall be furnished with one rod and angle bracket for attachment to both the equipment and ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrically on either side of the unit. Horizontal thrust restraints shall be Type WB.

2.3 FLEXIBLE CONNECTORS FOR PIPING

- A. General: Straight flexible connectors rated for temperatures, pressures, and fluids to be conveyed. Provide flexible connectors with the strength 4 times operating pressure at highest system operating temperature. Provide elbow flexible connectors with a permanently set angle.
- B. Metal Flexible Connectors: Fabricated of grade E phosphor bronze, monel or corrugated stainless steel tube covered with comparable bronze or stainless steel braid restraining and pressure cover. Sizes 3" and larger shall be flanged. Sizes 2-1/2" and smaller shall have male nipples. Lengths shall be as indicated:

NOMINAL DIAMETER (INCHES)	LENGTH (INCHES)
1/2"	9"
3/4"	10"
1"	11"
1-1/4"	12"
1-1/2"	12"
2"	12"
2-1/2"	12"
3"	18"
4"	18"

NOMINAL DIAMETER (INCHES)	LENGTH (INCHES)
5"	18"
6"	18"
8"	18"
10"	18"
12"	18"
14"	18"
16"	18"

- C. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Hoses shall be Type BSS.

2.4 VIBRATION ISOLATION EQUIPMENT BASES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries or a comparable product by one of the following:
1. Amber/Booth Company, Inc.
 2. Kinetics Noise Control.
- B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails. Mason Type WF and Mason Type ICS.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Inertia Base- Mason Industries BMK/KSL bases with modular corners: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel modular corner brackets on frame for isolation mountings and to provide for anchor bolts and equipment support.
 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.5 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

2.6 ACOUSTICAL FLOOR, CEILING AND WALL SEAL:

- A. Provide acoustical floor, ceiling, and wall seal where piping passes through mechanical equipment room/fan and air handling unit room walls, floors, or ceilings, and any noise-sensitive areas. The vibration isolator manufacturer shall provide a split seal consisting of two bolted pipe halves with 3/4" or thicker neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of 1" past either face of the wall. Where temperatures exceed 240°F, 10# density fiberglass shall be used in lieu of the sponge. Seals shall be Type SAWS.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- C. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
 - 3. Brace a change of direction longer than 12 feet (3.7 m).
- D. Install cables so they do not bend across edges of adjacent equipment or building structure.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- I. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 22 for piping flexible connections.

3.5 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. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to 90 percent of rated proof load of device.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
 - 9. Test and adjust air-mounting system controls and safeties.
 - 10. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust air-spring leveling mechanism.
- D. Adjust active height of spring isolators.
- E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 01 Section "Demonstration And Training."

3.8 GENERAL PROVISIONS

- A. Install vibration-and-noise isolation materials and equipment as indicated and in accordance with machinery manufacturer's instructions.
- B. Where neoprene elements of vibration isolator may be subjected to high pipe temperatures above 160 deg F, provide metal heat shields or thermal isolators.
- C. A minimum of 4" thick concrete housekeeping pads shall be provided under all floor mounted equipment. A minimum of 6" thick concrete housekeeping pads shall be provided under all air handling units, chillers, boilers and where indicated. Rest sub-bases on structural floor and reinforce with steel rods interconnected with floor reinforcing bars by tie bars hooked at both ends. Provide at least one (1) inch clearance between sub-bases and inertia bases, steel bases, and steel saddles with machinery in operation.
- D. All vibration isolators exposed to weather shall be hot dipped galvanized with springs coated with neoprene.
- E. Concrete inertia bases shall be a minimum of two (2) times the weight supported. Clearance between the underside of the inertia base and the housekeeping pad below shall not be less than 1 inch. Concrete shall be 3000 psi. Install inertia bases in accordance with the recommendations of the machinery manufacturer and the inertia base manufacturer.
- F. Anchor Bolts and Grout: Secure machinery to foundations and inertia bases with anchor bolts. Grout equipment with baseplates, the full area under baseplates with premixed non-shrinking grout. After grout has set, remove wedges, shims, and jack bolts and fill spaces with grout.
- G. Common Machinery Foundations: Mount electrical motors on the same foundations as driven machinery. Support piping connections, strainers, valves, and risers on the same foundation as the pumps.
- H. Vertical Stops: For machinery affected by wind pressure or having an operational weight different from installed weight, provide resilient vertical limit stops which prevent spring extension when weight is removed. Provide vertical stops for machinery containing liquid, such as water chillers, evaporative coolers, boilers, and cooling towers. Spring isolated or protected spring isolated machinery must rock and move freely within limits of stops or seismic restraint devices.
- I. Thrust Restraints: Where required, provide pairs of thrust restraints, symmetrically installed on both sides of the steady state line of thrust.
- J. Machinery: Provide vibration isolators, flexible connectors and seismic snubbers in accordance with manufacturer's recommendations. Machinery with spring isolators or protected spring isolators shall rock or move freely within limits of stops or seismic snubber restraints.
- K. Stability: Isolators shall be stable during starting and stopping of machinery without traverse and eccentric movement of machinery that would damage or adversely affect the machinery or attachments.

- L. Lateral Motion: The installed vibration isolation systems for each piece of floor or ceiling mounted machinery shall have a maximum lateral motion under machinery start up and shut down conditions of not more than 1/4-inch. Restrain motions in excess by approved spring mountings.
- M. Unbalanced Machinery: Provide foundation suspension systems specifically designed to resist horizontal forces for machinery with large unbalanced horizontal forces. Vibration isolator systems shall conform to the machinery manufacturer's recommendations.
- N. Non-Rotating Machinery: Mount non-rotating machinery in systems which include rotating or vibrating machinery on isolators having the same deflection as the hangers and supports for the pipe connected to.
- O. Unitized Machinery Assemblies: Unitized assemblies such as chillers with evaporator and condenser, and top mounted centrifugal compressor or unitized absorption refrigeration machines, structurally designed with end supports, may be mounted on steel rails and springs in lieu of steel bases and springs. Where the slab or deck is less than 4 inches thick, provide spring isolation units with the deflection double that of the vibration isolation schedule, up to a maximum static deflection of 5 inches.
- P. Roof and Upper Floor Mounted Machinery: On the roof or upper floors, mount machinery on isolators with vertical stops. Rest isolators on beams or structures designed and installed in accordance with the SMACNA ASMM Plate 61.
- Q. Vibration isolation ceiling hangers shall be installed so that the hanger rods do not touch the sides of the isolator housing, thereby seriously degrading the vibration isolation performance. Vibration isolation ceiling hangers shall be located so that the hanger housing may rotate 360° without touching any object.
- R. Electrical Connections: Provide flexible conduit or multiple conductor cable connections for machinery with sufficient extra length to permit 2 inch minimum displacement in any direction without damage.
- S. Systems Not to be Vibration Isolated: Do not provide vibration isolation for electrical raceways and conduits or for fire protection, storm, sanitary, and domestic water piping systems which do not include pumps or other vibrating, rotating, or pulsating equipment including control and pressure reducing valves.

3.9 PIPE ISOLATION:

- A. Horizontal Pipe Isolation
 - 1. Precompressed Suspension Spring Isolators: The first three pipe hangers in the main lines near the mechanical equipment provide precompressed suspension spring isolators. Floor supported piping shall rest on trained spring isolators. All precompressed suspension spring isolators hangers or the first three trained spring isolators mounts as noted above, will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceiling under occupied spaces, the first three hangers shall have 0.75" deflection for pipe sizes up to and including 3", 1.5" deflection for pipe sizes up to and including 6" and 2.5" deflection thereafter. All other hangers and mounts will have a minimum steel spring deflection of 0.75". Hangers shall be located as close to the overhead supports as practical.
 - 2. Combination Spring and Neoprene Suspension Hanger: For horizontal runs in Mechanical Equipment Rooms (including Air Handling Unit Rooms) other than those

hereinbefore specified, provide suspension spring hangers (combination spring and neoprene) with .75" minimum steel spring deflection.

B. Floor-Supported Piping:

1. Floor supports for piping in equipment rooms and adjacent to isolated equipment shall use vibration isolators as described hereinbefore and selected to the guidelines of hangers.
2. The first three adjacent floor supports shall be the restrained spring type with a blocking feature that prevents load transfer to equipment flanges as the piping is filled and drained.
3. Where piping is subject to larger thermal movement a slide plate shall be installed on the top of the isolator. Slide plate shall be teflon, graphite or steel.
4. Provide a thermal barrier where neoprene products are installed directly beneath steam or hot water lines.

C. Pipe Risers: Provide pipe riser supports with bearing plates and two layers of 1/4" thick ribbed or waffled neoprene pad loaded to not more than 50 psi. Separate isolation pads with 1/4" steel plate. Weld pipe riser clamps at anchor points to the pipe and to pairs of vertical acoustical pipe anchor mountings which shall be rigidly fastened to the steel framing.

D. Supports at Base of Pipe Risers: Piping isolation supports at the base of risers shall be two layers of 1/2" thick heavy-duty neoprene pad separated by 1/4" thick steel plate. Use bearing plates sized to provide a pad loading of not more than 500 psi. Weld the stanchion between the pipe and isolation support to the pipe and weld or bolt to the isolation support. Bolt isolation support to the floor slab with resilient sleeves and washers. Where supplementary steel is required to support piping, provide a maximum deflection of 0.08 inches at the mid-span of this steel under the load. Rigidly support piping from the supplementary steel with the supplementary steel isolated from the building structure with isolators.

E. Pipe Anchors: Attach each end of the pipe anchor to an omni-directional pipe isolator which in turn shall be rigidly fastened to the steel framing or structural concrete. Provide a telescoping pipe isolator of two sizes of steel tubing separated by a minimum 1/2" thick pad of heavy-duty neoprene or heavy-duty neoprene and canvas. Provide vertical restraints by similar material to prevent vertical travel in either direction. The load on the isolation material shall not exceed 500 psi.

3.10 EQUIPMENT ROOM SOUND ISOLATION:

- A. Do not allow direct contact between pipes or ducts and walls, floor slabs, roofs, ceilings or partitions of equipment rooms.
- B. Pipe Penetrations: All piping passing through Mechanical Equipment Room and Fan/Air Handling Unit Room walls, floors and ceilings shall be protected against sound leakage by means of an acoustical wall seal as described hereinbefore.
- C. Duct Penetrations: Provide with sound insulation equal to the sound attenuation value of the wall, floor, or ceiling penetrated.

3.11 FLEXIBLE PIPE CONNECTORS:

- A. Provide flexible connectors in accordance with Manufacturers instructions where piping systems serving vibration isolated equipment and as shown on the drawings. Flexible connectors shall be installed near the connection to the equipment. Where liquid pulsation dampening is

required, flexible connectors with spherical configuration may be used. Provide restraints for pipe connectors at pumps to prevent connector failure upon pump start-up. Flexible pipe connectors shall be twin-sphere type.

3.12 ISOLATION FOR SPECIFIC EQUIPMENT:

- A. The vibration isolator manufacture shall provide isolators for all pieces of equipment provided for the job. Isolator shall be selected by the isolator manufacturer on the basis of criteria as specified in the latest edition of ASHRAE Applications Handbook, unless a more stringent requirement is indicated on the drawings.
- B. Pumps:
 - 1. Provide metal flexible pipe connections at pump suction and discharge.
- C. Cabinet/In-Line Fan(s): Suspended – Provide combination spring and neoprene type isolator with a minimum deflection of 1½"; Mason Industries Type 30N, or approved equal.
- D. Cabinet Unit Heaters (Ceiling Hung Type): Provide combination spring and neoprene isolator, Mason Type W30, at 1.00" minimum deflection.
- E. Roof Mounted Air Handling Equipment: Provide 3" thick, light weight acoustical concrete (Perlite) within entire curb space.

END OF SECTION 23 05 48

SECTION 23 05 93

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.
 - b. Variable-air-volume systems.
 - 2. Balancing Hydronic Piping Systems:
 - a. Constant-flow hydronic systems.
 - b. Variable-flow hydronic systems.
 - c. Primary –Secondary hydronic systems.
 - d. Domestic hot water system.

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 30 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 30 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.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC.
 - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC as a TAB technician.
- B. TAB Conference: Meet with Architect, Owner, Commissioning Agent and Engineer 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 14 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 Architect, Owner, Construction Manager, 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 building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations. After occupancy no activities are permitted during normal school operating hours.

- 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.
- C. The project will have all systems fully commissioned by an independent Commissioning Company.

1.7 COORDINATION

- A. Notice: Provide fourteen 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. All testing and balancing shall be performed by an independent test and balance agency that specializes in and whose business is limited to the testing and balancing of mechanical systems. The agency must have membership in the "Associated Air Balance Council" and have an Engineer certified by the National Examining Board. All final reports shall be signed and officially stamped by the certified test and balance engineer.
- B. 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. Baltimore Air Balance Company.
 - 2. Baumgartner, Inc.
 - 3. American Testing, Inc.
 - 4. Chesapeake Testing and Balancing Engineers, Inc.
 - 5. Weisman, Inc.
 - 6. Butler Balancing Company, Inc.
 - 7. Flood and Sterling, Inc.
 - 8. WAE 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 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.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. 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.
- I. Examine terminal units, such as space fan coil units, and verify that they are accessible and their controls are connected and functioning.
- J. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine operating safety interlocks and controls on HVAC equipment.
- O. 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 REQUIREMENTS

- A. Test and balance all heating, ventilating, and air conditioning systems. The work shall include, but not be limited to, the following:
- B. Witness all leak tests for ductwork and air distribution systems.
- C. Balance and adjust all air distribution systems (including air terminal devices) to within 5% of design air quantities, including maximum and minimum heating, cooling, and set-points of air handling units.
- D. Adjust all fans to required speeds for design air flow, including changing sheaves.

- E. Test the capacity and performance of all equipment and adjust to design conditions.
- F. Operate and test all systems under all sequences of operation and adjust equipment and controls for efficient and stable operation.
- G. Test and balance all systems under adequate load conditions. If, in the opinion of the Engineer, there is insufficient load to properly test and balance the systems, perform sufficient preliminary balancing and adjustment to permit operation of the systems until such time as final testing and balancing can be done.
- H. Retest or rebalance the systems as required during the guarantee period.
- I. Provide water and air test and balance for all air handling systems (AHU's, DOAS units, BCU's). Retest and rebalance all equipment at the completion of the project.

3.4 COORDINATION BY THE MECHANICAL CONTRACTOR

- A. Coordinate the testing and balancing work with the work of other trades.
- B. Furnish complete and up-to-date contract documents, shop drawings, installation and coordination drawings, submittal data, and other information to the testing and balancing agency so that the work is performed using all required system and equipment data.
- C. Plan and schedule testing and balancing at required times during construction. Review all plans, schedules, and procedures with the Engineer before proceeding.
- D. Prepare all systems for testing and balancing. Provide clean filters in all air systems and clean strainers and traps in the piping systems. Provide final flushing of piping systems if required.
- E. Make all necessary adjustments and repairs to the work, correcting any malfunctions or deficiencies which are disclosed by testing and balancing.

3.5 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.

3.6 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, 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.

3.7 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."

3.8 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps and heat-recovery equipment, under final balanced conditions.
 - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 6. Obtain approval from Architect, Owner, Construction Manager, Commissioning Authority for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 - 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 - 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

- C. Measure air outlets and inlets without making adjustments.
 - 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 - 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.9 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - 1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 - 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure for the critical terminal (heat pump) unit.
 - 3. Measure total system airflow. Adjust to within indicated airflow.
 - 4. Set terminal unit at maximum airflow and adjust static pressure sensor to deliver the designed maximum airflow. When total airflow is correct, balance the air outlets downstream from terminal (heat pump) units the same as described for constant-volume air systems.
 - 5. Set terminal units airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 - 6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
 - 8. Record final fan-performance data.

3.10 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

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

- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open all manual valves for maximum flow.
 - 2. Check liquid level in expansion tank.
 - 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
 - 4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
 - 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 - 6. Set system controls so automatic valves are wide open to heat exchangers.
 - 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 - 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.
 - 9. For variable flow systems develop a plan to simulate diversity (i.e. heating system coils are sized based on heat wheel failure).

3.11 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:
 - 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gauge heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Architect, Owner, Construction Manager and Commissioning Authority and comply with requirements in Division 23 Section "Hydronic Pumps."
 - 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved. Monitor motor performance during procedures and do not operate motors in overload conditions.
 - 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 - 4. Report flow rates that are not within plus or minus 10 percent of design.
- B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.
- C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
- D. Set calibrated balancing valves, if installed, at calculated presettings.
- E. Measure flow at all stations and adjust, where necessary, to obtain first balance. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating devices.
- F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

- G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
 - 1. Determine the balancing station with the highest percentage over indicated flow.
 - 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 - 3. Record settings and mark balancing devices.
- H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures, including outdoor-air temperature.
- I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
- J. Check settings and operation of each safety valve. Record settings.

3.12 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

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

3.13 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

- A. Balance the primary-circuit flow first and then balance the secondary circuits.

3.14 PROCEDURES FOR WATER-TO-WATER HEAT EXCHANGERS

- A. Measure water flow through all circuits.
- B. Adjust water flow to within specified tolerances.
- C. Measure inlet and outlet water temperatures.
- D. Measure inlet and outlet pressure.
- E. Check settings and operation of safety and relief valves. Record settings.

3.15 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 or ECMS: 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.

3.16 PROCEDURES FOR CHILLERS

- A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
 - 1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
 - 2. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
 - 3. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
 - 4. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
 - 5. Capacity: Calculate in tons of cooling.
 - 6. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.17 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.18 BOILERS

- A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

3.19 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 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.

3.20 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 5 percent.
 - 2. Air Outlets and Inlets: Plus or minus 5 percent.
 - 3. Heating-Water Flow Rate: Plus or minus 10 percent.
 - 4. Geothermal-Water Flow Rate: Plus or minus 10 percent.

3.21 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.

3.22 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. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance; 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 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 (mm), and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 - 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 (mm), and bore.
- f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

3. Test Data (Indicated and Actual Values):

- a. Total air flow rate in cfm (L/s).
- b. Total system static pressure in inches wg (Pa).
- c. Fan rpm.
- d. Discharge static pressure in inches wg (Pa).
- e. Filter static-pressure differential in inches wg (Pa).
- f. Preheat-coil static-pressure differential in inches wg (Pa).
- g. Cooling-coil static-pressure differential in inches wg (Pa).
- h. Heating-coil static-pressure differential in inches wg (Pa).
- i. Outdoor airflow in cfm (L/s).
- j. Return airflow in cfm (L/s).
- k. Outdoor-air damper position.
- l. Return-air damper position.
- m. Vortex damper position.

F. 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 (mm) o.c.
- f. Make and model number.
- g. Face area in sq. ft. (sq. m).
- h. Tube size in NPS (DN).
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm (L/s).
- b. Average face velocity in fpm (m/s).
- c. Air pressure drop in inches wg (Pa).
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
- e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
- f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
- g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
- h. Water flow rate in gpm (L/s).
- i. Water pressure differential in feet of head or psig (kPa).
- j. Entering-water temperature in deg F (deg C).
- k. Leaving-water temperature in deg F (deg C).
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig (kPa).
- n. Refrigerant suction temperature in deg F (deg C).
- o. Inlet steam pressure in psig (kPa).

- G. Gas-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 (kW).
- 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 (mm), and bore.
- n. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

2. Test Data (Indicated and Actual Values):

- a. Total air flow rate in cfm (L/s).
- b. Entering-air temperature in deg F (deg C).
- c. Leaving-air temperature in deg F (deg C).
- d. Air temperature differential in deg F (deg C).
- e. Entering-air static pressure in inches wg (Pa).
- f. Leaving-air static pressure in inches wg (Pa).
- g. Air static-pressure differential in inches wg (Pa).
- h. Low-fire fuel input in Btu/h (kW).
- i. High-fire fuel input in Btu/h (kW).
- j. Manifold pressure in psig (kPa).
- k. High-temperature-limit setting in deg F (deg C).
- l. Operating set point in Btu/h (kW).
- m. Motor voltage at each connection.
- n. Motor amperage for each phase.
- o. Heating value of fuel in Btu/h (kW).

- 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 (mm), and bore.
- h. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

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 (mm), and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 - g. Number, make, and size of belts.
- 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Suction static pressure in inches wg (Pa).
- 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 (deg C).
 - d. Duct static pressure in inches wg (Pa).
 - e. Duct size in inches (mm).
 - f. Duct area in sq. ft. (sq. m).
 - g. Indicated air flow rate in cfm (L/s).
 - h. Indicated velocity in fpm (m/s).
 - i. Actual air flow rate in cfm (L/s).
 - j. Actual average velocity in fpm (m/s).
 - k. Barometric pressure in psig (Pa).
- J. 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 (L/s).
 - b. Entering-water temperature in deg F (deg C).
 - c. Leaving-water temperature in deg F (deg C).
 - d. Water pressure drop in feet of head or psig (kPa).
 - e. Entering-air temperature in deg F (deg C).
 - f. Leaving-air temperature in deg F (deg C).
- K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm (L/s).
 - g. Water pressure differential in feet of head or psig (kPa).
 - h. Required net positive suction head in feet of head or psig (kPa).
 - i. Pump rpm.
 - j. Impeller diameter in inches (mm).
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.

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

L. Instrument Calibration Reports:

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

3.23 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 5 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 Architect, Owner, Engineer, Commissioning Authority.
- 2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect, Owner, Engineer, Commissioning Authority.
- 3. Architect, Owner, Engineer, 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. 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.

3.24 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 23 05 93

SECTION 23 09 00
INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Related Sections include the following:
 - 1. Division 23 Section "Meters and Gauges for HVAC Piping" for measuring equipment that relates to this Section.
- C. Comply with all code requirements and fire safety requirements.
- D. The Automatic Temperature Control System (ATC) shall tie-in to existing Energy Management System (EMS) shall be electric/electronic actuation direct digit control (DDC), BTL BACnet Certified System.
- E. Coordinate controls with controlled equipment. Upon completion of the work, calibrate and adjust all controls for proper function. Electric wiring, power to ATC panels, including interlock wiring for equipment such as air handlers, fans, VAV terminal control units, terminal heating units, split systems, etc., shall be furnished and installed under this section. The ATC Contractor shall provide transformers, wiring, 120 volt power wiring, power to ATC panels, necessary relays, and controls, etc., not provided under Divisions 26, 27 and 28 for the automation of the ATC/EMS as required by the Sequence of Operation and the Input/Output Schedule. All electrical work shall conform to the applicable requirements of Divisions 26, 27 and 28. All control wiring shall be installed in EMT conduit in accordance with Divisions 26, 27 and 28, except for control wiring to terminal control units located above accessible ceilings, which shall be plenum-rated cable.
- F. All automatic temperature control dampers, valves and separable wells for immersion elements furnished by the Control Manufacturer shall be installed by the Mechanical Contractor or his sheetmetal subcontractor under the Control Manufacturer's supervision.
- G. Reference is hereby made for this Contractor to become familiar with Division 25, 27 and 28 of these specifications. Familiarization is for coordination purposes only. The Control Contractor shall provide all necessary relays, contacts, interlock wiring, etc., not provided under Division 26, 27, and 28 for the automation of the ATC and EMS Systems as required by the sequence of operation and input/output schedule. The automatic temperature control Contractor shall provide all power wiring for all control panels including emergency power for the heating water system. Coordinate where power can be obtained with the Electrical Contractor. The Control Contractor shall coordinate all requirements with the building Fire Alarm System. The Control Contractor

shall provide all additional devices and interlock wiring required for the automation of the ATC System and monitoring of the EMS System.

- H. Provide all labor, materials, equipment and services necessary for and incidental to furnishing and installing a complete stand-alone Electric/Electronic/DDC Automatic Temperature Control System to meet the requirements of the sequence of operation. The System Supplier shall assume and execute full responsibility to select, furnish, install, connect, test, calibrate, and place into operation all specified components, assemblies, and accessories needed for a complete and functional system of HVAC monitoring and control in full compliance with the requirements of the specifications.
- I. The Control Contractor shall provide control and monitoring system devices and sensors that conform to the standards of NFPA 72D. Devices and sensors shall be provided to suit the function of the Input/Output Point Summary shown on the Contract Drawings.
- J. The ATC Contractor shall coordinate with Division 23, Mechanical, and shall furnish and install all items necessary to meet the requirements of the Sequence of Operation and the Energy Management System (EMS) indicated on the drawings and as required in this specification. The ATC System shall be one of Direct Digital Control utilizing electric/electronic actuation.
- K. The direct digital control system shall include all necessary and specified control equipment properly installed in accordance with the specifications and drawings and shall include, but not be limited to the automatic temperature control and energy management system of the following:
 - 1. Heating System
 - 2. Unit Heater/Cabinets Unit Heaters.
 - 3. VRV/VRF System
 - 4. Electrical Room Heat and Ventilation Control.
 - 5. Miscellaneous Interlock Wiring for Fan Speed Switches, Fan On-Off Switches, Dust Collectors, Ambient Air Cleaners, Time Delays, Heating Units, Heat Recovery Wheels, Make-Up Air Units, Liquid Sensors, Split A/C Units, Kiln Hoods, Monitors, Sump Pumps, Plumbing Equipment, Fire Protection Tank, Emergency Generator, Site Lighting Systems, flow meters, etc.
- L. The ATC Contractor shall provide input/output devices and sensors, conduit system and interlock wiring between sensors and the existing Energy Management System. All sensors and devices provided for tie-in to the existing energy management system shall match the existing the existing system. The ATC Contractor shall provide input/output devices and sensors, conduit system and interlock wiring between sensors and the existing Energy Management System. All system controls shall be fully compatible in every way to current ATC system, whether factory or field assembled. At end of the project these controls must be the latest version and the head end of the system is to be upgraded to the latest version as well for complete compatibility. Use same extended warranty working as was done in prior projects for all components used in the control system.
- M. EMS:
 - 1. The Energy Management System (EMS) shall be provided by the current supplier, coordinate with Owner for more information. This includes modification of the existing Energy Management System and the furnishing and installing of all hardware, software and accessories required to perform the functions listed and as described hereinafter in the Sequence of Operations.
 - 2. The Contractor shall modify and extend the existing Energy Management System to enable the expansion of the system to include the monitoring and control of the items indicated in the control point schedule (I/O Summary) and listed in these Contract Documents and Specifications.
 - 3. The Contractor shall provide programming to incorporate the new points into the data file of the existing CPU.

- N. The project will require a network control unit(s), etc and all auxiliary devices required for a complete system as per specified Sequence of Operation. The ATC Contractor will not be relieved of any responsibility or requirements necessary for a complete and operational ATC System. The ATC System shall be an all-electric/electronic actuation, direct digitally controlled. Coordinate all control requirements with the equipment manufacturers for a fully turnkey system. Extend EMS Interface Communication line and provide all necessary devices, software, etc., for remote control and monitoring from the school district EMS. The EMS shall include all hardware, software, and programming to graphically display the building, equipment and system.
- O. The building shall be provided with stand-alone local controls. The Energy Management System shall override local controls when "Local-Remote" System switches are in the remote position. Position of all "Local-Remote" switches shall be monitored by the Energy Management System. If failure of the Energy Management System occurs when the "Local-Remote" System switch is indexed to remote control, all controls functions shall revert back to local controls. Reset to remote controls shall be manual.

1.3 DEFINITIONS

- A. DDC: Direct digital control.
- B. I/O: Input/output.
- C. MS/TP: Master slave/token passing.
- D. PC: Personal computer.
- E. PID: Proportional plus integral plus derivative.
- F. RTD: Resistance temperature detector.

1.4 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 - 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
 - 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
 - 3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
 - 4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
 - 5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
 - 6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
 - 7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
 - 8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within minimum tolerances as follows, unless stricter tolerances are specified for specific devices hereinafter:

- a. Water Temperature: Plus or minus 1 deg F (0.5 deg C).
- b. Water Flow: Plus or minus 5 percent of full scale.
- c. Water Pressure: Plus or minus 2 percent of full scale.
- d. Space Temperature: Plus or minus 1 deg F (0.5 deg C).
- e. Ducted Air Temperature: Plus or minus 1 deg F (0.5 deg C).
- f. Outside Air Temperature: Plus or minus 2 deg F (1.0 deg C).
- g. Dew Point Temperature: Plus or minus 3 deg F (1.5 deg C).
- h. Temperature Differential: Plus or minus 0.25 deg F (0.15 deg C).
- i. Relative Humidity: Plus or minus 5 percent.
- j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
- k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
- l. Airflow (Terminal): Plus or minus 10 percent of full scale.
- m. Air Pressure (Space): Plus or minus 0.01-inch wg (2.5 Pa).
- n. Air Pressure (Ducts): Plus or minus 0.1-inch wg (25 Pa).
- o. Carbon Monoxide: Plus or minus 5 percent of reading.
- p. Carbon Dioxide: Plus or minus 50 ppm.
- q. Electrical: Plus or minus 5 percent of reading.

1.5 SEQUENCE OF OPERATION

- A. Refer to Drawings for Sequence of Operation.

1.6 SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - 1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 - 2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
 - 3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- B. 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. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 - 2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 - 3. Wiring Diagrams: Power, signal, and control wiring.
 - 4. Details of control panel faces, including controls, instruments, and labeling.
 - 5. Written description of sequence of operation.
 - 6. Schedule of dampers including size, leakage, and flow characteristics.
 - 7. Schedule of valves including flow characteristics.
 - 8. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.

- b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
- 9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
- 10. Controlled Systems:
 - a. Schematic and logic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram.
 - d. Points list.
 - e. Control Systems Network Architecture and Riser Diagram, including all nodes, devices, interfaces, and interconnections.
- 11. Data Sheets of all products.
- 12. Points Lists for all physical and virtual (software) points to be provided at minimum, including for each point the tag, type, range, unit's descriptor, address, project specific attributes, and the like.
- 13. Include in the Points List details of the physical terminations and interconnections for each end device on the networks, including the associated Node, cable terminations, termination location and referenced sequences, special functions to be applied and cross-referenced drawings. All field wiring tags shall be cross-referenced between drawings.
- 14. Information specifically required by Authorities Having Jurisdiction.
- 15. Details of the training to be provided, including outlines for each session.
- 16. Details of the commissioning sheets and procedures proposed.
- 17. Details of ISP, and associated requirements to be provided by the Owner, at its cost, in order for the contractor to complete the work.
- 18. Final graphic floor plan with final room numbers.
- 19. All school district's Standard acronyms.
- C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with BACnet (BTL Certified).
- D. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.
- E. Samples for Verification: For each color required, of each type of thermostat or sensor cover.
- F. Software and Firmware Operational Documentation: Include the following:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
 - 5. Software license required by and installed for DDC workstations and control systems.
- G. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- H. Qualification Data: For Installer and manufacturer.

- I. Field quality-control test reports.
- J. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
 - 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 - 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - 5. Calibration records and list of set points.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project. The office shall have the required training certificates.
- B. 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.
- C. Comply with ASHRAE 135 for DDC system components.
- D. Supplier shall have an in-place support facility with technical staff, spare parts inventory, and all necessary test and diagnostic equipment.
- E. The systems shall be complete in all respects and shall be installed by skilled personnel. The Control Contractor shall have a successful history in the installation and maintenance of automatic temperature control systems similar in size and performance to that specified herein.
- F. All electrical wiring in connection with the Automatic Temperature Control System shall be furnished and installed by the ATC Contractor. This shall include all interlock wiring between fans, pumps, heating and cooling systems, heaters, terminal control units, etc.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update the entire building/systems district wide (including existing) to latest version of software at Project completion.

1.9 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

- B. Coordinate equipment with Division 28 Section "Intrusion Detection" to achieve compatibility with equipment that interfaces with that system and with building master clock.
- C. Coordinate equipment with Division 28 Section "Access Control" to achieve compatibility with equipment that interfaces with that system.
- D. Coordinate equipment with Division 27 Section "Clock Systems" to achieve compatibility with equipment that interfaces with that system.
- E. Coordinate equipment with Division 28 Section "PLC Electronic Detention Monitoring and Control Systems" to achieve compatibility with equipment that interfaces with that system.
- F. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.
- G. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.
- H. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- I. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.
- J. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- K. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.
- L. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

1.10 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. Replacement Materials: One replacement diaphragm or relay mechanism for each unique controller, thermostat, and positioning relay.
 - 2. Maintenance Materials: Three thermostat adjusting keys.
 - 3. Software: Provide back/recovery disk for all software.

1.11 WORK BY OTHERS

- A. Automatic Temperature Control valves and separable wells for immersion elements furnished by the control manufacturer shall be installed by the Mechanical Contractor under the Manufacturer's supervision. The Control Contractor shall deliver to the Mechanical Contractor valves and wells for installation within the various systems.
- B. All automatic dampers furnished by the control manufacturer shall be installed by the Mechanical Contractor under the control manufacturer's supervision.

1.12 GUARANTEE AND INSTRUCTION:

- A. The control system including all components, system software, parts and assemblies herein specified shall be free from defects in workmanship and materials under normal use and service. After completion of the installation, the Control Manufacturer shall regulate and adjust all thermostats, control valves, control motors, and other equipment provided under this contract. If, within two (2) years from the date of substantial completion, any of the equipment herein described is proved to be defective in workmanship or materials, it will be replaced or repaired at no additional cost to the Owner. The Control Manufacturer shall, after completion, provide any service incidental to the proper performance of the Control System under guarantees outlined above for a period of two (2) years. Normal maintenance of the system is not to be considered part of the guarantee. All corrective modifications made during warranty service periods shall be updated on all user documentation including "as-built" shop drawings and on user and manufacturer archived software disks.
- B. The Control Contractor shall completely check out, calibrate and test all connected hardware to insure that the system performs in accordance with the approved specifications and sequences of operation submitted.
- C. Upon completion of the work, the control drawing (AutoCadd Drawing printed in color) encased in heavy plastic shall be provided in each mechanical equipment space. Layout shall show all control equipment and the function of each item indicated. All AutoCadd Control Drawings shall be archived on a CD/DVD or external hard drive and turned over to the Owner.
- D. Upon completion of the work, the Control Contractor shall have completely adjusted the entire control system. He shall arrange to instruct the Owner's representative on the operation of the control system for a period of not less than five (2) eight (8) hour days. All training shall be by the Control Contractor shall be on site and shall utilize specified manuals and as-built documentation. In addition to the start-up instructional period the ATC Contractor shall provide one (1) eight hour instructional period 6 months after the initial instructions and one (1) eight hour instructional period 12 months after the initial instructions (i.e., one during cooling season/one during the heating season).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONTROL SYSTEM

- A. Available Manufacturer:
 - 1. Schneider Electric, or equal.

- B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.
- C. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.3 UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
 - 1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
 - 2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
 - 3. Enclosure: Dustproof rated for operation at 32 to 120 deg F (0 to 50 deg C).
 - 4. Enclosure: Waterproof rated for operation at 40 to 150 deg F (5 to 65 deg C).

2.4 ALARM PANELS

- A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch- (1.5-mm-) thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, NEMA 1, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels. Provide means of storing control system instructions and drawings inside cabinet for future reference. Provide UL listed cabinets for use with line voltage devices.
- B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.
 - 1. Alarm Condition: Indicating light flashes and horn sounds.
 - 2. Acknowledge Switch: Horn is silent and indicating light is steady.
 - 3. Second Alarm: Horn sounds and indicating light is steady.
 - 4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
 - 5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.5 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:
 - 1. Available Manufacturers:

- a. Honeywell.
 - b. Schneider Electric
2. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.
 3. Wire: Twisted, shielded-pair cable.
 4. Insertion Elements in Ducts: 18 inches (460 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
 5. Averaging Elements in Ducts: 72 inches (1830 mm) long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
 6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
 7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Setpoint adjustment: Exposed.
 - b. Override Button: Concealed.
 - c. Display: LED.
 - d. Color: Standard Manufacturer's Color.
 - e. Orientation: Vertical.
 8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws. Provide for Gymnasium and/or auxiliary gym spaces and room security areas.

C. RTDs and Transmitters:

1. Available Manufacturers:
 - a. Schneider Electric
 - b. Honeywell
2. Accuracy: Plus or minus 0.2 percent at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 18 inches (460 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
5. Averaging Elements in Ducts: 24 feet (7.3 m) long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.
6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.
 - b. Set-Point Indication: Concealed.
 - c. Thermometer: Concealed.
 - d. Color: Manufacturer's Standard Color.
 - e. Orientation: Vertical.
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws. Provide for corridors, and where indicated on the Drawings.

D. Smart Humidity Sensors: Bulk polymer sensor element.

1. Manufacturers:
 - a. Vaisala – Sole Source for Dewpoint Sensors and acceptable for space and duct humidity sensors.
 - b. Vaisala or Veris – For space and duct humidity sensors.

2. Accuracy: 2 percent full range with linear output.
3. Room Sensor Range: 20 to 80 percent relative humidity. Vaisala Model Humicap H Sensor.
4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.
 - b. Set-Point Indication: Concealed.
 - c. Thermometer: Concealed.
 - d. Color: Manufacturer's Standard Color.
 - e. Orientation: Vertical.
5. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, (Radiation Shield Vaisala Model 2212HM) suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F (minus 30 to plus 85 deg C). Provide PPS grid with stainless steel netting to protect sensor. Provide electric heater option.
6. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity. Vaisala Model HMP 233.

E. Room Sensor Cover Construction: Manufacturer's standard locking covers.

1. Set-Point Adjustment: Concealed.
2. Set-Point Indication: Concealed.
3. Thermometer: Concealed.
4. Color: Architect shall select.
5. Orientation: Vertical.

F. Room sensor accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.
2. Guards: Locking, solid metal, ventilated.
3. Adjusting Key: As required for calibration and cover screws.

2.6 STATUS SENSORS

- A. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- B. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- C. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- D. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

2.7 THERMOSTATS

- A. Available Manufacturers:
 1. Schneider Electric

- B. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.
 - 1. Label switches "FAN ON-OFF"; "FAN HIGH-LOW-OFF"; or "FAN HIGH-MED-LOW-OFF".
 - 2. Mount on single electric switch box.
- C. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
 - 1. Automatic switching from heating to cooling.
 - 2. Preferential rate control to minimize overshoot and deviation from set point.
 - 3. Set up for four separate temperatures per day.
 - 4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
 - 5. Short-cycle protection.
 - 6. Programming based on weekday, Saturday, and Sunday or every day of week.
 - 7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
 - 8. Battery replacement without program loss.
 - 9. Thermostat display features include the following:
 - a. Time of day.
 - b. Actual room temperature.
 - c. Programmed temperature.
 - d. Programmed time.
 - e. Duration of timed override.
 - f. Day of week.
 - g. System mode indications include "heating," "off," "fan auto," and "fan on."
- D. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.
- E. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.
 - 1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
 - 2. Selector Switch: Integral, manual on-off-auto.
- F. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
 - 1. Bulbs in water lines with separate wells of same material as bulb.
 - 2. Bulbs in air ducts with flanges and shields.
 - 3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
 - 4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
 - 5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
 - 6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

- G. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F (24 deg C) above normal maximum operating temperature, and the following:
 - 1. Reset: Manual.
 - 2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.
- H. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
- I. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, automatic-reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.
 - 1. Bulb Length: Minimum 20 feet (6 m).
 - 2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.
- J. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-automatic- reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or above set point.
 - 1. Bulb Length: Minimum 20 feet (6 m).
 - 2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.
- K. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig (172 kPa), and cast housing with position indicator and adjusting knob.

2.8 CONTROL CABLE

- A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."
- B. All wiring shall be installed in a designated EMT conduit raceway unless otherwise specified. All junction boxes shall have covers painted "Safety Green" and be rigid steel. Minimum size conduit shall be 3/4".
- C. Where it is not possible to conceal raceways in finished locations (i.e., existing masonry walls), surface raceway (wiremold) may be used as approved by the Architect.
- D. Individual conductors shall be color-coded and in addition, shall be numbered in the field to identify the particular terminal to which it is attached. Field numbering shall be performed with Brady Markers wrapped around the wire near the terminal connection. All wires shall be terminated with pressure type connectors suitable for wire size, material, and terminal connection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that power supply is available to control units and operator workstation.
- B. Verify that duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

3.2 INSTALLATION

- A. Install software in control units. Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. The Automatic Temperature Control System shall be designed, installed, and commissioned in a fully turnkey, fully implemented and fully operational manner.
- D. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) above the floor.
 - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- E. Install guards on all space sensors (all types) and thermostats.
- F. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- G. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
- H. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."
- I. All safety controls shall be hard-wired so as to be functional in the hand/manual or automatic mode.
- J. The ATC Contractor shall be responsible to provide all power to ATC panels, controllers and devices. Coordinate obtaining power for ATC Systems with the Electrical Contractor.
- K. All sensors located on exterior walls shall be provided with an insulated sub base.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

- C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
1. Install cable in rigid conduit in all mechanical equipment rooms.
 2. Install exposed cable in raceway.
 3. Install concealed cable in raceway except where above accessible ceilings.
 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
 8. All conduits and raceways shall be installed level, plumb, at right angles to the building lines, and shall follow the contours of the building line.
- D. All Wiring and tubing shall be properly supported and run in a neat and workmanlike manner. All wiring and tubing exposed and in equipment rooms shall run parallel to or at right angles to the building structure. All piping and wiring within enclosures shall be neatly bundled and anchored to prevent restriction to devices and terminals.
- E. The Control Contractor shall be responsible for all electrical installation required for a fully functional control and automation system and not shown on the electrical plans or required by the electrical specifications. All wiring shall be in accordance to all local and national codes.
1. All line voltage wiring, all wiring exposed, and all wiring in equipment rooms shall be installed in conduit in accordance to the electrical specifications.
 2. All electric and electronic wiring shall be #18 AWG minimum THHN and shielded if required.
 3. All wiring in the central control room shall be concealed in an approved manner.
- F. Control Systems Wiring:
1. All conduit raceways, wiring, accessories and wiring connections required for the installation of the Controls Systems shall be provided by the Controls Contractor. All wiring shall comply with the requirements of applicable portions of the Electrical Trade work and all local and national electric codes and the requirements of the AHJ.
 2. All Controls Systems wiring materials and installation methods shall comply with the original equipment manufacturer recommendations and standards.
 3. The sizing type and provision of cable, conduit, cable trays and raceways shall be the design responsibility of the Controls Contractor.
 4. Class 2 Wiring
 - a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
 - b. Conduit is not required for Class 2 wiring in concealed accessible ceiling locations. Class 2 wiring not installed in conduit shall be supported every 5ft. from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines.
 5. Class 2 signal wiring and 24VAC power may be run in the same conduit. Power wiring 120VAC and greater shall not share the same conduit with Class 2 signal wiring.
 6. Perform circuit tests using qualified personnel only. Provide necessary instruments and equipment to demonstrate that:
 - a. All circuits are continuous and free from short circuits and grounds.
 - b. All circuits are free from unspecified grounds; that resistance to ground of all circuits is no less than 50 megaohms.
 - c. All circuits are free from induced voltages.

7. Provide complete testing for all cables and wiring. Provide all equipment, tools, and personnel as necessary to conduct these tests.
 8. Provide for complete grounding of all signal and communication cables, panels and equipment so as to ensure integrity of Controls Systems operation. Ground cabling and conduit at panel terminations. Do not create ground loops
- G. Line Voltage Power Sources
1. 120 -volt AC circuits for the Controls Systems shall be taken by the Controls Contractor from electrical trade panelboards and circuit breakers. Coordinate locations with the Electrical Contractor.
 2. Circuits used for the Controls Systems shall be dedicated to these Controls Systems and shall not be used for any other services.
 3. Controls DDC terminal unit controllers may use 120-volt AC power from motor power circuits.
- H. Controls Systems Raceways
1. All wiring shall be installed in conduit or raceway except as noted elsewhere in the Specification. Minimum conduit size 3/4".
 2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
 3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the supporting surface.
 4. UL/ULC Listed Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls and for final connection to equipment.
- I. Penetrations:
1. Firestopping for all penetrations used by dedicated Controls Systems conduits and raceways shall be by the ATC Contractor.
 2. All openings in fire proofed or fire stopped components shall be closed by the ATC Contractor using approved fire resistive sealant.
 3. All wiring passing through penetrations, including walls, shall be in sleeves, conduit or enclosed raceway.
 4. No penetrations through building structural elements, slabs, ceilings and walls shall be made before receipt of written approval from the Architect.
- J. Controls Systems Identification Standards:
1. Node Identification: All nodes shall be identified by a permanent label fastened to the outside of the enclosure. Labels shall be suitable for the node environmental location.
 2. Cable shall be labeled at every termination with cross-referencing to record documentation.
 3. Raceway Identification: Exposed covers to junction and pull boxes of the FMS raceways shall be identified at primary points.
 4. Wire Identification: All low and line voltage wiring shall be identified by a number, as referenced to the associated shop and record drawing, at each termination.
 5. Wires and cabling shall not be spliced between terminations. Cable shields shall be single end grounded – typically at the panel end outside the panel.
 6. Suggested color coding, for use at the Contractors option, are:
 - a. Analog Input Cable Yellow
 - b. Analog Output Cable Tan
 - c. Binary Input Cable Orange
 - d. Binary Output Cable Violet
 - e. 24 VAC Cable Gray
 - f. General Purpose Cable Natural
 - g. Tier 1 Comm Cable Purple
 - h. Other Tier Comm Cable Blue

- K. Controls Specific Installation Requirements
1. The Mechanical Trade Contractor shall install all in-line mechanical devices including temperature wells, pressure taps, duct smoke detectors, airflow stations, etc.
 2. Controls DDC terminal unit controllers may use 120-volt AC power from motor power circuits.
 3. The Mechanical Contractor shall install all in-line devices including control valves, dampers, etc.
 4. Input flow measuring devices shall be installed in compliance with ASME Guidelines.
 5. Electronic Signal Isolation Transducers: Whenever an analog output signal from the Controls Systems is to be connected to an external control system as an input (such as chiller control panel), or it is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between building systems. Provide optical isolation between building systems.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 2. Test and adjust controls and safeties.
 3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 6. Test each system for compliance with sequence of operation.
 7. Test software and hardware interlocks.
 8. Provide complete testing for all cables and wiring. Provide all equipment, tools and personnel as necessary to conduct these tests.
- C. DDC Verification:
1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 2. Check instruments for proper location and accessibility.
 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 4. Check instrument tubing for proper fittings, slope, material, and support.
 5. Check installation of air supply for each instrument.
 6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
 7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 8. Check temperature instruments and material and length of sensing elements.
 9. Check control valves. Verify that they are in correct direction.
 10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
 11. Check DDC system as follows:

- a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using milliamper meter at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Flow:
 - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - b. Manually operate flow switches to verify that they make or break contact.
6. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
7. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

- B. Adjust initial temperature and humidity set points.
- C. Occupancy Adjustments: Within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to twenty (20) visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."
- B. Schedule instruction with Owner. Provide at least a 7-day notice to the Contractor and Engineer of training date. All Operation and Maintenance Manuals shall be provided to Owner three (3) weeks prior to training. Contractor shall be responsible for all operation and maintenance until Owner has had training.
- C. Owner's Instructions: Provide services of manufacturer's technical representative to completely instruct Owner in all aspects of system maintenance and operation; or a minimum of five (5) 8-hour days to instruct Owner's personnel in operation and maintenance of electric control system. The ATC Contractor shall submit a functional test check list including all points and sequence of operation points to be reviewed and verified during the Owner Instruction Period. All sequences shall be tested for all air handling systems, heating plant and cooling plant systems, and 100% of all terminal units (terminal heating units, fan coil/blower coil units, VAV control unit(s), etc., for each air handling unit zone. The check list shall include columns for "satisfactory", "unsatisfactory", and "comments" for each line item. The check list shall be submitted and reviewed as a shop drawing prior to the instructional period. The Contractor shall include all the check lists in a 3-ring binder (10 copies/sets minimum) for the representatives for the instructional procedure.

3.7 LOCAL CONTROL AND EMS CONTROL:

- A. Each system shall operate automatically as described in the sequence of operations when locally controlled; i.e., in the hand position and/or when loss of communications of the remote EMS occurs.
- B. Refer to Drawings for additional information.

3.8 VERIFICATION

- A. Fully test and verify all aspects of the Controls Systems Contract work on a point/system/integrated operational basis for all points, features and functions specified.
- B. Acceptance Check Sheet
 1. Prepare a check sheet that includes all points and functions of the Work.
 2. Submit the check sheet to the Architect for approval 60 days prior to testing.
 3. Complete the check sheets for all items and functions of the work. Initial each entry with time/date as record of having fully calibrated and tested the Work. Submit to the Architect as record.
 4. The Architect will use the check sheets as the basis for Acceptance Testing with the Controls Systems Contractor.

- C. Provide all necessary specialist labor, materials and tools to demonstrate to the Architect that the Controls Systems have been verified and are operating in compliance with the Controls Systems Contract. Prepare a list of noted deficiencies signed by both the Architect and the Controls Contractor.
- D. Contractor shall submit a functional test check list including all points and sequence of operation points to be reviewed and verified during the Owner Instruction Period. All sequences shall be tested for all systems and equipment. The check list shall include columns for SATISFACTORY, UNSATISFACTORY, and COMMENTS for each line item. The check list shall be submitted and reviewed as a shop drawing prior to the instructional period. The Contractor shall include all the check lists in 3-ring binder (10 copies/sets minimum) for the representatives for the instructional procedure.
- E. Promptly rectify all listed deficiencies and submit in writing to the Architect a signed report that this has been done.
- F. The Architect will retest the deficiencies in conjunction with the controls Contractor at the Architect's option.

END OF SECTION 23 09 00